Central Radio Propagation Laboratory

IONOSPHERIC PREDICTIONS

for

December

1963

TB 11-499-9/TO 31-3-28

U.S. DEPARTMENT of COMMERCE
National Bureau of Standards
Number 9/Issued September 1963

U.S. DEPARTMENT OF COMMERCE
Luther H. Hodges, Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

Central Radio Propagation Laboratory

Ionospheric Predictions

for December 1963

[Formerly "Basic Radio Propagation Predictions," CRPL Series D.]

Number 9

Issued

September 1963

The CRPL Ionospheric Predictions are issued monthly as an aid in determining the best sky-wave frequencies over any transmission path, at any time of day, for average conditions for the month. Issued three months in advance, each issue provides tables of numerical coefficients that define the functions describing the predicted worldwide distribution of foF2 and M(3000)F2 and maps for each even hour of universal time of MUF(Zero)F2 and MUF(4000)F2.

NOTE: Department of Defense personnel see back cover.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget (June 19, 1961).

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 15 cents.

Annual subscription (12 issues) $1.50 (50 cents additional for foreign mailing).

National Bureau of Standards

The functions of the National Bureau of Standards are set forth in an Act of Congress, March 3, 1901, as amended. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. The Bureau also serves as the Federal technical research center in a number of specialized fields.

Central Radio Propagation Laboratory

The Central Radio Propagation Laboratory at Boulder, Colorado, is the central agency of the Federal Government for the collection, analysis, and dissemination of information on propagation of radio waves at all frequencies along the surface of the earth, in the atmosphere, and in space, and performs scientific studies looking toward new techniques for the efficient use and conservation of the radio spectrum. To carry out this responsibility, the CRPL—

1. Acts as the central agency for the conduct of basic research on the nature of radio waves, the pertinent properties of the media through which radio waves are transmitted, the interaction of radio waves with those media, and on the nature of radio noise and interference effects. This includes compilation of reports by other foreign and domestic agencies conducting research in this field and furnishing advice to government and nongovernment groups conducting propagation research.

2. Performs studies of specific radio propagation mechanisms and performs scientific studies looking toward the development of techniques for efficient use and conservation of the radiofrequency spectrum as part of its regular program or as requested by other government agencies. In an advisory capacity, coordinates studies in this area undertaken by other government agencies.

3. Furnishes advisory and consultative service on radio wave propagation, on radiofrequency utilization, and on radio systems problems to other organizations within the United States, public and private.

4. Prepares and issues predictions of radio wave propagation and noise conditions and warnings of disturbances in these conditions.

5. Acts as a central repository for data, reports, and information in the field of radio wave propagation.

6. Performs scientific liaison and exchanges data and information with other countries to advance knowledge of radio wave propagation and interference phenomena and spectrum conservation techniques, including that liaison required by international responsibilities and agreements.

Introduction

The "Central Radio Propagation Laboratory Ionospheric Predictions" is the successor to the former "Basic Radio Propagation Predictions," CRPL Series D. To make effective use of these predictions, National Bureau of Standards Handbook 90, "Handbook for CRPL Ionospheric Predictions Based on Numerical Methods of Mapping," should be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, price 40 cents. This Handbook includes required additional data, nomographs and graphical aids, as well as methods for the use of the predictions. The Handbook supersedes the obsolete NBS Circular 465.

The basic prediction appears in tables 1 and 2, presenting predicted coefficients for foF2 and M(3000)F2 defining the numerical map functions describing the predicted worldwide variation of these characteristics. With additional auxiliary information, these coefficients may be used as input data for electronic computer programs solving specific high frequency propagation problems. The basic equations, their interpretation, and methods of using the numerical maps are described in two papers by W. B. Jones and R. M. Gallet, "The Representation of Diurnal and Geographic Variations of Ionospheric Data by Numerical Methods," Volume 66D, Number 4, July–August 1962, pages 419–438, and "Methods for Applying Numerical Maps of Ionospheric Characteristics," Volume 66D, Number 6, November–December 1962, pages 649–662, both in the Journal of Research of the National Bureau of Standards, Section D. Radio Propagation. The predicted numerical map coefficients of tables 1 and 2 may be purchased in the form of a tested set of punched cards. Write to the Prediction Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado, to arrange for the purchase of the set of punched cards and for further information and assistance in the application of computer methods and numerical prediction maps to specific propagation problems.

The graphical prediction maps, derived from the basic prediction, are provided for those unable to make use of an electronic computer. Figures 1 to 12 present world maps of MUF (Zero) F2 and MUF(4000)F2 for each even hour of universal time. Figures 13 to 16 present the same predictions for hours 00 and 12 universal time for the North and South Polar areas. Predicted polar maps for each even hour of universal time may be obtained by special arrangements with the Central Radio Propagation Laboratory. Handbook 90 describes methods for including regular E–F1 propagation. Figure A is a graph of predicted and observed Zürich sunspot numbers which shows the recent trend of solar activity. Table A lists observed and predicted Zürich smoothed relative sunspot numbers and includes the sunpot number used for the current prediction.

Members of the U.S. Army, Navy, or Air Force desiring the Handbook and the Ionospheric Predictions should send requests to the proper service address; for the Navy: The Director, Naval Communications, Department of the Navy, Washington, D.C., 20350; for the Air Force: Directorate of Command Control and Communications, Headquarters, United States Air Force, Washington, D.C., 20330. Attention: AFOCCAA. Army personnel should refer to the Handbook as TM 11–499 and to the monthly predictions as TB 11–499–( ), predictions for the month of December 1963 being distributed in September 1963 and designated TB 11–499–(9), and should requisition these through normal publication channels.

Information concerning the theory of radio wave propagation and such important problems as absorption, field intensity, lowest useful high frequencies, etc., is given in National Bureau of Standards Circular 462, "Ionospheric Radio Propagation." A revised work is in preparation which will be announced in the Ionospheric Prediction series when available. Additional information about radio noise may be found in C.C.I.R. Report Number 65, "Revision of Atmospheric Noise Data," International Telecommunication Union, Geneva, 1957.

Reports to this Laboratory of experience with these predictions would be appreciated. Correspondence should be addressed to the Prediction Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado.

Erratum for Table 1: **See page following Fig 16.**

Table A

Observed and Predicted Zurich Smoothed Relative Sunspot Numbers

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1952	43	42	39	36	34	32	31	29	28	28	27	26
	(53)	(51)	(52)	(52)	(52)	(52)	(51)	(49)	(46)	(43)	(38)	(33)
1953	24	22	20	19	17	15	13	12	11	10	9	7
	(30)	(29)	(27)	(24)	(22)	(21)	(20)	(18)	(18)	(17)	(16)	(15)
1954	6	6	4	3	4	4	5	7	8	8	10	12
	(14)	(12)	(11)	(10)	(10)	(9)	(8)	(8)	(8)	(10)	(10)	(11)
1955	14	16	20	23	29	35	40	46	55	64	73	81
	(12)	(14)	(14)	(13)	(16)	(18)	(22)	(27)	(30)	(31)	(35)	(42)
1956	89	98	109	119	127	137	146	150	151	156	160	164
	(48)	(53)	(60)	(68)	(77)	(89)	(95)	(105)	(119)	(135)	(147)	(150)
1957	170	172	174	181	186	188	191	194	197	200	201	200
	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)
1958	199	201	201	197	191	187	185	185	184	182	181	180
	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(150)
1959	179	177	174	169	165	161	156	151	146	141	137	132
	(150)	(150)	(150)	(150)	(146)	(143)	(141)	(142)	(141)	(139)	(137)	(137)
1960	129	125	122	120	117	114	109	102	98	93	88	84
	(136)	(135)	(133)	(130)	(125)	(120)	(118)	(115)	(110)	(108)	(105)	(100)
1961	80	75	69	64	60	56	53	52	52	51	50	49
	(100)	(90)	(90)	(90)	(85)	(85)	(80)	(75)	(70)	(70)	(65)	(60)
1962	45	42	40	39	39	38	36	34	32	31	30	30
	(60)	(50)	(48)	(45)	(42)	(37)	(34)	(31)	(29)	(28)	(27)	(34)
1963												
	(31)	(28)	(26)	(25)	(25)	(25)	(23)	(21)	(20)	(18)	(18)	(17)*
1964												

Note: Final numbers are listed through June 1962, the succeeding values being based on provisional data. The predicted numbers are in parentheses.

* Number used for predictions in this issue.

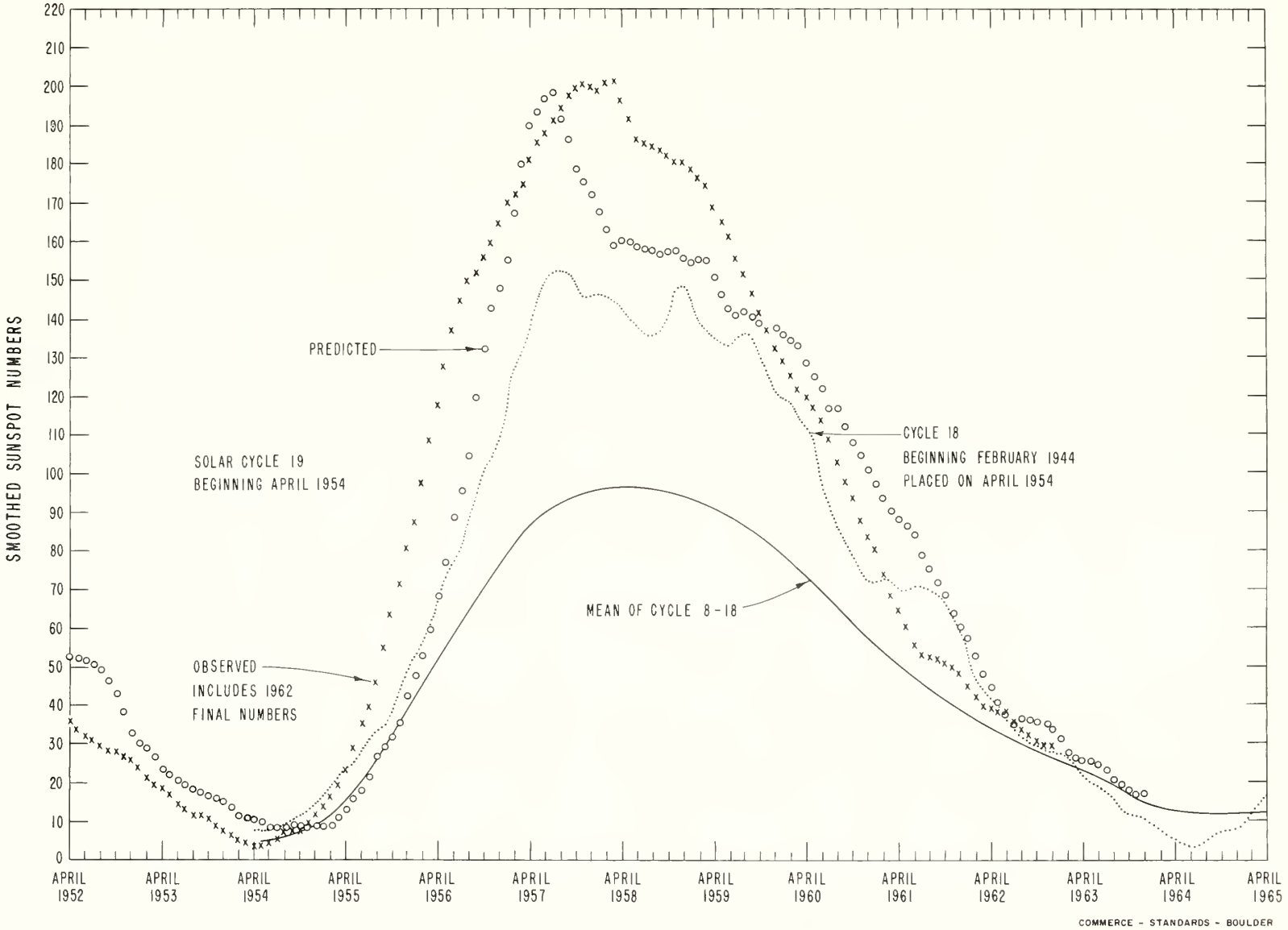

FIG. A. PREDICTED AND OBSERVED SUNSPOT NUMBERS

TABLE I

TIME VARIATION

GEOGRAPHICAL VARIATION

Hormonic		0	1		2		3		4	
	K \ S	0	1	2	3	4	5	6	7	8
I	0	6.6046908E 00	2.0638742E 00	2.1299832E 00	-8.2286459E-01	3.1623041E-01	-1.0234261E-01	-3.6554986E-01	2.0699715E-01	-1.9452983E-01
	1	-2.4826107E 00	-2.1547072E 00	-6.7686699E-01	-3.0698635E-01	-4.8058936E-01	-1.1799288E 00	-1.1412372E 00	-1.4195784E-03	-4.0385585E-01
	2	-1.9237274E 00	-4.7110266E 00	3.9681245E 00	8.3360309E 00	3.1382858E 00	-1.5541125E 00	-2.7722340E 00	1.1576562E-01	9.5919893E-01
	3	1.5249192E 01	2.4836581E 01	2.9235603E 01	2.8226628E 00	1.7704547E 01	8.5009426E 00	1.3331718E 01	2.9670922E-02	-1.5464931E 00
	4	-1.8716462E 01	-7.3556287E 00	-2.8609040E 01	-1.6174457E 01	-5.1181268E 00	1.8422321E 01	3.0785538E 01	-7.0162349E 00	-8.2800704E 00
	5	-7.2354510E 01	-1.2719588E 02	-1.7654156E 02	-5.2199602E 00	-1.0128577E 02	-2.7774233E 01	-5.2756794E 01	-1.1279356E 00	1.4038226E 01
	6	5.5542628E 01	3.1779924E 01	2.8127863E 01	-4.7448865E 01	-4.3554319E 01	-7.0863891E 01	-1.0668518E 02	2.9603582E 01	3.5916503E 01
	7	1.5980414E 02	2.8644086E 02	4.2495089E 02	9.3434088E 00	2.3685603E 02	4.0917889E 01	9.5033323E 01	7.3762988E-01	-3.6617779E 01
	8	-5.6789306E 01	-1.7393045E 01	6.7196041E 01	1.8404526E 02	1.5603478E 02	1.2438670E 02	1.7378145E 02	-6.1164845E 01	-7.2875763E 01
	9	-1.6409348E 02	-2.8543061E 02	-4.4289079E 02	-1.1384982E 01	-2.3951202E 02	-2.5729099E 01	-7.8994730E 01	1.7501214E 00	4.0792076E 01
	10	9.8110569E 00	-2.3241002E 01	-1.3884856E 02	-1.9765082E 02	-1.7896939E 02	-1.0160339E 02	-1.3322457E 02	6.1499654E 01	6.8886033E 01
	11	6.3467243E 01	1.0373618E 02	1.6642569E 02	4.7560799E 00	8.6955988E 01	5.3037055E 00	2.4588334E 01	-1.5691375E 00	-1.6235864E 01
	12	9.5088468E 00	1.9252224E 01	6.6384864E 01	6.9703834E 01	6.8203911E 01	3.1392648E 01	3.8540111E 01	-2.3238167E 01	-2.4423687E 01
II	13	-4.1084361E-02	-5.1868214E-02	-9.9969680E-02	1.0368425E-02	8.1825707E-02	7.9690591E-02	1.3559309E-01	-8.6603010E-02	-4.5515419E-02
	14	-2.1821569E-01	-1.3660401E-01	-2.2153039E-01	1.0346715E-01	-7.9567887E-02	2.7270447E-02	7.4006377E-02	-4.4729844E-02	-3.6928163E-02
	15	-6.3693679E-01	-1.2936490E 00	-5.1633240E-01	7.8539217E-01	1.1467534E 00	1.1151070E-01	-1.4468497E-01	6.5589471E-01	7.7288934E-02
	16	-1.5411682E 00	-2.1207895E-01	-5.8331677E-01	-1.5900723E 00	-2.0164011E 00	-5.6947908E-01	-7.0078049E-01	7.7753577E-01	3.4723828E-02
	17	-9.2138497E-01	-2.8018028E-01	-7.4609464E 00	-2.6550696E 00	-4.9199006E 00	-5.2203689E 00	-5.1091393E 00	3.7160864E 00	2.3029193E 00
	18	2.1841168E 01	1.8065539E 01	-2.7352499E 00	2.6637258E 00	5.5559794E 00	1.3600081E 00	-6.3466610E-01	1.6014930E 00	1.9357052E 00
	19	4.0992194E 01	3.0443712E 01	4.5416291E-01	-6.5939710E 00	-5.6564661E 00	1.7722073E 00	2.5619285E-01	-1.3765350E 01	-1.0279867E 00
	20	4.3114750E 01	2.2291656E 01	2.2944117E 01	1.9723394E 01	1.9995555E 01	4.8849560E 00	1.0.68397E 01	-1.0637409E 01	-7.0205982E-02
	21	8.3589864E 00	4.2652705E 01	8.3096688E 01	1.5233677E 01	3.8022462E 01	4.1277148E 01	4.3442518E 01	-3.5993440E 01	-1.3133395E 01
	22	-2.6932725E 02	-2.0848109E 02	6.2906951E 01	-5.8819728E 01	-6.9878591E 01	-2.6237280E 01	2.7682957E 00	-1.3861865E 01	-2.5145222E 01
	23	-2.8039052E 02	-1.8535330E 02	-4.8059654E 00	8.3759204E 00	-3.5018497E 00	-2.1815971E 01	4.8755744E 00	7.3008570E 01	6.7762469E 00
	24	-2.3142273E 02	-1.2066710E 02	-1.1723980E 02	-7.6335643E 01	-6.2477971E 01	-1.3390711E 01	-4.7072158E 01	5.1917922E 01	3.1601849E-01
	25	6.2749636E 00	-2.6996587E 02	-2.9284008E 02	-8.5859410E 00	-1.1298497E 02	-1.2169126E 02	-1.5184107E 02	1.4272180E 02	2.5222297E 01
	26	1.1686120E 03	9.0585216E 02	-3.0938156E 02	3.0612957E 02	3.2002218E 02	1.3224630E 02	2.4485472E-01	5.2373095E 01	1.2594063E 02
	27	7.0090469E 02	4.5739145E 02	1.7154670E 01	2.3073118E 01	4.7201105E 01	6.4756420E 01	-2.2979088E 01	-1.5968456E 02	-2.1343139E 01
	28	4.9434269E 02	2.2232210E 02	2.1491210E 02	1.1860367E 02	7.5576154E 01	1.7910142E 01	9.1801780E 01	-1.1131603E 02	-4.2208607E 00
	29	-9.0662327E 01	6.3897800E 02	4.4702327E 02	-6.6741612E 01	1.5198385E 02	1.6055245E 02	2.5396392E 02	-2.6885644E 02	-1.5453367E 01
	30	-2.2977842E 03	-1.8394132E 03	5.8943218E 02	-6.7671900E 02	-6.7331075E 02	-2.7198965E 02	-1.9430499E 01	-9.5823883E 01	-2.8137296E 02
	31	-7.4371020E 02	-4.9034036E 02	-1.8890184E 01	-5.2353066E 01	-7.0526300E 01	-7.3306463E 01	3.4415649E 01	1.5693119E 02	2.8400204E 01
	32	-4.4969761E 02	-1.6273607E 02	-1.6531572E 02	-7.3158895E 01	-2.5554937E 01	-1.6215001E 01	-8.1344819E 01	1.0711561E 02	9.0486430E 00
	33	1.4305551E 02	-6.6030503E 02	-2.9896255E 02	1.1831519E 02	-8.9196031E 01	-9.3094134E 01	-2.0254296E 02	2.4116001E 02	-4.2859038E 00
	34	2.0900010E 03	1.7545221E 03	-4.6612009E 02	6.7773904E 02	6.5803195E 02	2.5490341E 02	3.0902061E 01	8.2718942E 01	2.8329075E 02
	35	2.8266356E 02	1.9063956E 02	6.8197107E 00	2.6084066E 01	3.1183477E 01	2.8370801E 01	-1.6636557E 01	-5.7566293E 01	-1.3115866E 01
	36	1.4317745E 02	3.7624430E 01	4.4028673E 01	1.2404900E 01	-5.4219530E 00	8.0028163E 00	2.7059073E 01	-3.7567775E 01	-5.0919593E 00
	37	-6.6114762E 01	2.5036550E 02	6.6519381E 01	-5.5968598E 01	1.6644076E 01	1.7910327E 01	6.1950446E 01	-8.3130001E 01	5.2469729E 00
	38	-7.1639588E 02	-6.3357362E 02	1.2424354E 02	-2.5212558E 02	-2.4069762E 02	-8.8152391E 01	-1.3646948E 01	-2.6789827E 01	-1.0478566E 02
III	39	2.5022819E-01	9.7880598E-02	-1.1597310E-01	2.9477389E-02	7.9526296E-02	2.4721371E-02	1.9272287E-02	-4.0771556E-02	-1.3808996E-02
	40	3.9195637E-02	8.2756448E-02	-1.3163789E-01	2.2218986E-02	-1.4706959E-03	5.4804242E-02	4.0428081E-02	-4.9014753E-03	2.2367395E-03
	41	3.4660870E-01	9.2295643E-01	1.9109830E-01	-2.0377817E-01	7.8904796E-03	-3.8791226E-01	-1.6787239E-03	1.6206094E-01	-5.4299426E-02
	42	8.0890491E-02	-8.3299572E-02	-6.1882801E-01	3.1734544F-01	-3.9815623E-03	1.6383465E-01	-1.5407603E-03	1.4276183E-01	-2.1637338E-03
	43	-8.2144127E-01	-1.0663704E-01	5.4764680E-01	-4.5432155E-01	1.0786275E-01	-2.2530315E-01	-9.6140482E-03	4.5530972E-01	-7.1565206E-03
	44	-3.7501085E-02	-2.2694397E-01	3.2045175E 00	-9.0638677E-02	-5.6815880E-03	-7.7718822E-03	-1.6995995E-02	3.2780244E-02	2.1933130E-02
	45	-2.5149270E-01	-1.8887139E 00	-1.6238234E-01	3.7729884E-01	3.4209643E-03	2.1093356E 00		-3.4208580E-01	1.3571598E-03
	46	-2.1482566E-02		2.4970121E 00	-7.4181414E-01	4.1596097E-02	-3.5546263E-01		-2.4279055E-01	7.3759705E-03
	47	-1.1408713E-01		-3.6380208E 00	7.2555060E-02	-3.6519047E-01	2.2337961E-01		-6.4612986E-01	6.9435515E-03
	48	5.4577079E-02		-1.1496905E 01	6.1773850E-02	-2.8343358E-03	-1.0552344E-01			-2.9027645E-02
	49	2.5848006E-01		-3.6637270E-01	7.1972699E-02	-6.1762773E-03	-2.2613598E 00			
	50			-3.2513983E 00	1.6962572E-01	-6.3132378E-02	1.8774345E-02			
	51			4.5132215E 00		3.0713887E-01	3.0700417E-02			
	52			1.1208840E 01			1.5126849E-01			

GEOGRAPHICAL VARIATION

Hormonic		5		6		7		8	
	K \ S	9	10	11	12	13	14	15	16
I	0	8.7292458E-02	2.3307540E-01	-4.1116595E-02	-9.4931015E-03	-4.0791578E-02	-9.6252538E-02	7.6243933E-02	-1.7082309E-02
	1	1.3328403E-01	-5.0395380E-02	5.1960424E-02	2.3166339E-01	-3.7959733E-02	3.9655796E-02	-2.3961708E-02	-5.9973972E-02
	2	-2.9180954E-01	-9.7576848E-01	1.6519073E-01	9.6166947E-02	1.4329805E-01	4.3011663E-01	-3.7851292E-01	2.5717262E-02
	3	-1.4497618E-01	4.3746601E-02	-5.5143088E-02	-2.8040048E-01	5.4560363E-02	-4.3997270E-02	3.2495490E-02	7.5483785E-02
	4	1.9298976E-01	7.7824257E-01	-1.1799191E-01	-1.0591855E-01	-9.5145394E-02	-3.5717390E-01	3.2930374E-01	

I - Main latitudinal variation. Mixed latitudinal and longitudinal variation: II - First order in longitude, III - Second order in longitude

Notation: For each entry the number given by the first eight digits and sign is multiplied by the power of ten defined by the last two digits and sign.

PREDICTED COEFFICIENTS D_{SK} DEFINING THE FUNCTION $\Gamma(\lambda,\theta,t)$ FOR MONTHLY MEDIAN f_o F2 (Mc/s)

DECEMBER 1963

TABLE 2

TIME VARIATION

GEOGRAPHICAL VARIATION

Harmonic		0	1		2		3	
	K \ S	0	1	2	3	4	5	6
I	0	3.0529609E 00	-7.4897122E-02	-2.7453423E-01	2.0423567E-02	-9.8258440E-02	1.3658496E-02	-3.7028459E-02
	1	2.1074066E-01	7.1096686E-02	1.3858490E-01	3.9974941E-02	4.3738720E-02	-1.3421946E-01	-3.4928882E-03
	2	9.9106596E-01	5.0521797E-01	2.0290322E 00	3.0994686E-01	6.3172416E-03	-3.7882650E-01	-1.5268425E-01
	3	5.0356007E-01	-2.9837132E-01	4.5905215E-01	-5.1478942E-01	-1.4840792E-01	4.4089961E-01	-1.5406790E-01
	4	-2.4346058E 00	-8.4271071E-01	-3.2174678E 00	-1.7537209E 00	4.3164212E-01	1.3000740E 00	8.2584238E-01
	5	-1.6739824E 00	5.9337033E-01	-9.3638277E-01	1.0036019E 00	4.2561765E-01	-5.3143058E-01	3.6093179E-01
	6	1.7707299E 00	5.2369912E-01	2.2142037E 00	2.7411680E 00	-3.9424265E-01	-1.6349684E 00	-1.0077340E 00
	7	1.0992439E 00	-3.4266370E-01	3.9586712E-01	-5.3783701E-01	-2.9013628E-01	2.0587643E-01	-2.0812992E-01
	8	-2.8514656E-01	-5.8868806E-02	-8.0623562E-01	-1.3223367E 00	1.0432588E-01	7.1536803E-01	3.9221733E-01
II	9	-4.4550167E-02	-3.3897282E-02	1.7635363E-02	-1.0377829E-02	2.2248725E-02	1.4674526E-02	8.9349511E-03
	10	-7.3661023E-02	-2.9946582E-02	-5.0698293E-02	-1.6784018E-03	3.3546088E-04	2.7206373E-02	5.0437568E-03
	11	1.8742433E-01	-8.0694524E-02	1.1349212E-01	-1.4810422E-02	1.5371461E-01	2.5700417E-03	-5.6188275E-02
	12	-1.5150526E-01	-1.4024109E-01	-4.8453487E-01	4.5130406E-02	-1.1138610E-01	6.9292642E-03	4.4643263E-02
	13	3.6932312E-01	2.0543908E-01	9.3224833E-02	8.9734859E-02	-1.7973024E-01	-2.8864793E-02	2.3123055E-01
	14	5.9523584E-01	1.6786324E-01	-5.6448889E-02	-1.0229123E-01	-1.2469365E-01	-7.1560279E-02	7.0430871E-02
	15	-8.5947727E-01	2.9273133E-01	-2.5662833E-01	2.1622950E-02	-8.8298386E-01	-9.0945632E-03	1.6673845E-01
	16	7.3647476E-01	1.1591501E 00	3.0959215E 00	-9.1907983E-02	5.8532013E-01	-1.1740734E-02	-1.8050482E-01
	17	-8.9439411E-01	6.4509081E-02	-1.7786793E 00	-7.3302119E-02	1.4337433E-01	4.2355165E-02	-1.1244578E 00
	18	-1.6079759E 00	1.0317439E-01	2.2390511E 00	1.5480222E-01	7.4649060E-01	7.9226859E-02	-2.3396140E-01
	19	1.3177149E 00	-6.8664246E-01	1.0655180E-01	2.3882633E-02	1.6960258E 00	1.3377663E-02	-1.8142186E-02
	20	-1.1944502E 00	-2.4505309E 00	-5.7198181E 00	1.0260301E-01	-1.1172442E 00	2.0805487E-02	1.1862779E-01
	21	8.7190838E-01	-1.1534753E 00	4.4901947E 00	4.2811373E-03	5.2672474E-01	-7.0238957E-02	1.4096950E 00
	22	1.7953680E 00	-1.0129954E 00	-5.5414126E 00	1.7174007E-02	-1.6016516E 00	-1.3096998E-01	2.0527877E-01
	23	-6.8284808E-01	3.6899720E-01	6.1934528E-02	-1.5165750F-02	-1.0269683E 00	-5.7852584E-03	-1.2287740E-01
	24	6.7954183E-01	1.5812736E 00	3.4600556F 00	-5.6265138E-02	6.9438341E-01	-1.0270559E-02	2.2570310E-02
	25	-3.5191891E-01	9.8779241E-01	-2.8582495E 00	-7.7099838E-03	-5.2210875E-01	3.9121937E-02	-4.7036233E-01
	26	-7.8032557E-01	8.5939536F-01	3.5043615E 00	-1.0552111E-02	1.1062210E 00	7.0042948E-02	-4.7149273E-02
III	27	-1.8750261E-02	4.0073518E-03	2.7807350E-02	2.0224743E-05	6.9618560E-03	2.2479472E-04	-3.2258733E-03
	28	-4.9148066E-02	-1.1527013E-02	2.6154893E-02	1.0498127F-04	8.4121017E-03	2.9902281E-04	7.4507314E-03
	29	-1.5634379E-01	-6.8529580E-02	-7.9589950E-02	2.6301922F-03	-3.0104361E-02	-5.6397429E-04	
	30	7.0066454E-02	-6.1545272E-02	-7.5170996E-02	5.6082764E-04	-6.3725911E-02		
	31	-3.1051366E-01	-1.2942797E-01	-1.8183080E-01	-8.4102896E-04	-2.3532797E-02		
	32	8.2598988E-02	-9.1464673E-02	-3.2006521E-01	-1.1347074E-03	-1.3746922E-03		
	33	3.4584005E-01	1.8994354E-01	2.5642985E-01	-3.6646273E-03	6.5585266E-02		
	34	-1.1980907E-01	2.0814865E-01	1.1684156F-01		1.5543014E-01		
	35	7.2544516E-01	1.4279874E-01	4.4142206F-01				
	36		3.4677029E-01	4.5833415E-01				

GEOGRAPHICAL VARIATION

Harmonic		4		5		6	
	K \ S	7	8	9	10	11	12
I	0	6.6727906E-04	-1.7064704E-05	1.8572469E-02	2.3835946E-02	-1.1938134E-02	-2.2304156E-04
	1	-4.2756481E-03	-1.2430202F-01	2.4093278E-02	1.2791527E-02	2.8569731E-03	2.1642818E-02
	2	-6.5033918E-03	-1.6685244E-03	-3.1244038E-02	-4.6546275E-02	1.9971457E-02	-3.3687294E-03
	3	-1.0448699E-03	1.4722272E-01	-2.4735815E-02	-1.9107775E-02		-2.2209886E-02

I - Main latitudinal variation. Mixed latitudinal and longitudinal variation: II - First order in longitude, III - Second order in longitude.

Notation: For each entry the number given by the first eight digits and sign is multiplied by the power of ten defined by the last two digits and sign.

PREDICTED COEFFICIENTS D_{SK} DEFINING THE FUNCTION $\Gamma(\lambda,\theta,t)$ FOR MONTHLY MEDIAN M(3000)F2

DECEMBER 1963

DECEMBER 1963 UT=00

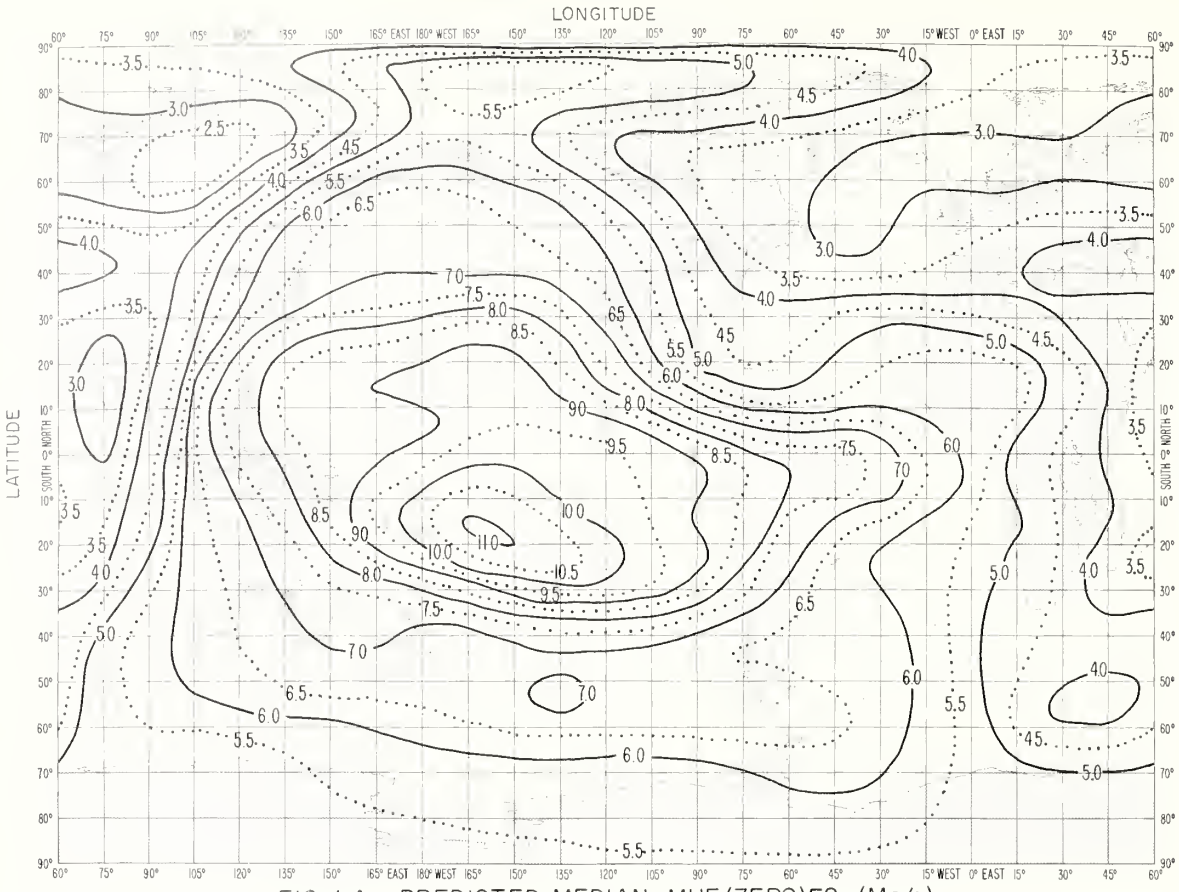

FIG 1 A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

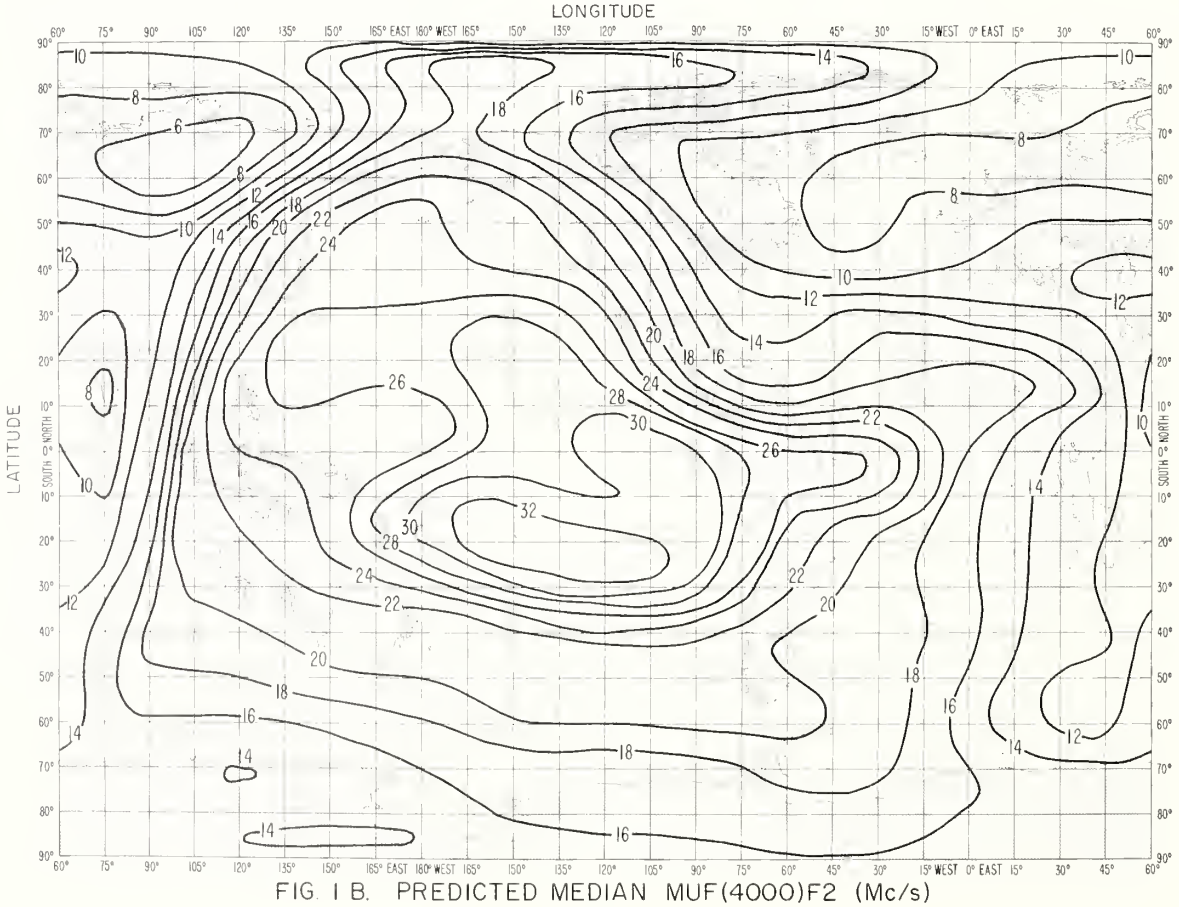

FIG. 1 B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

DECEMBER 1963 UT=02

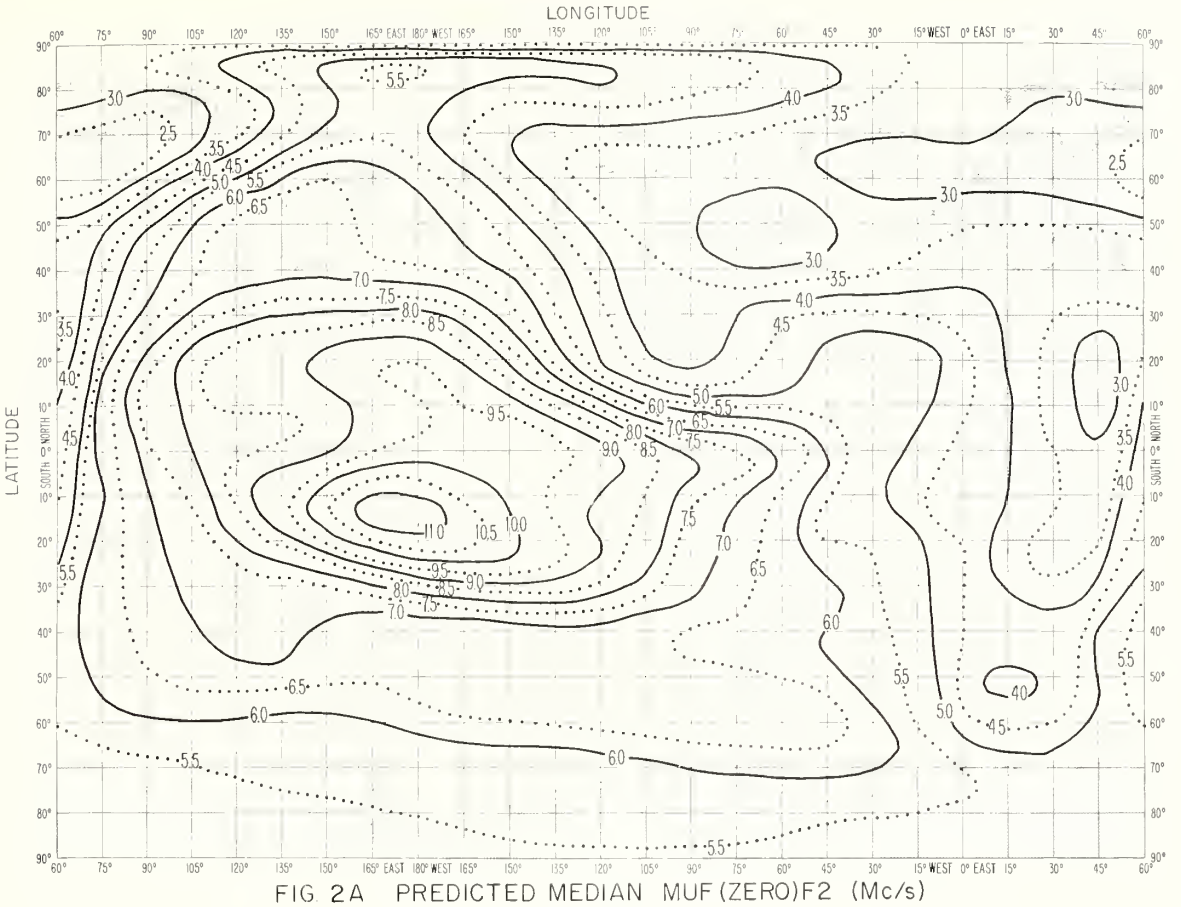

FIG. 2A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

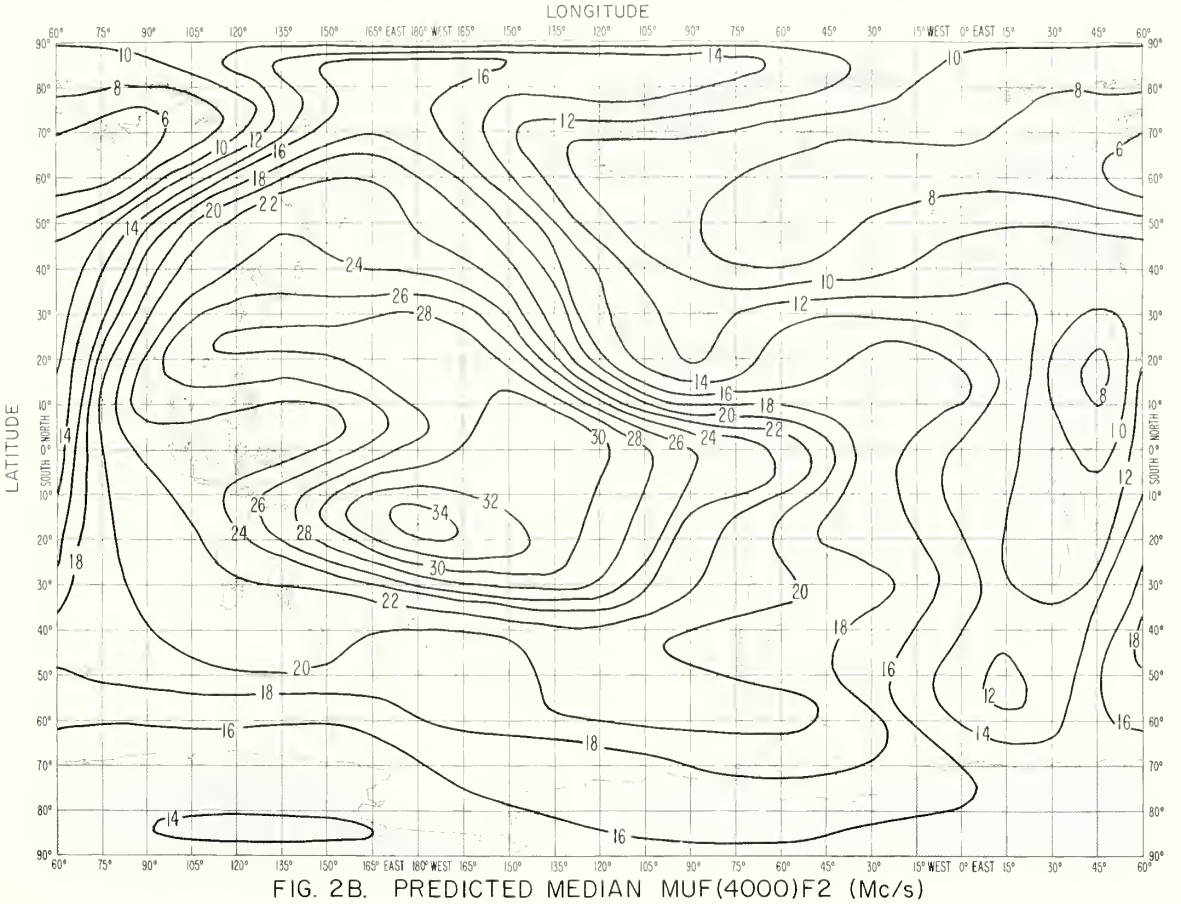

FIG. 2B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

DECEMBER 1963 UT=04

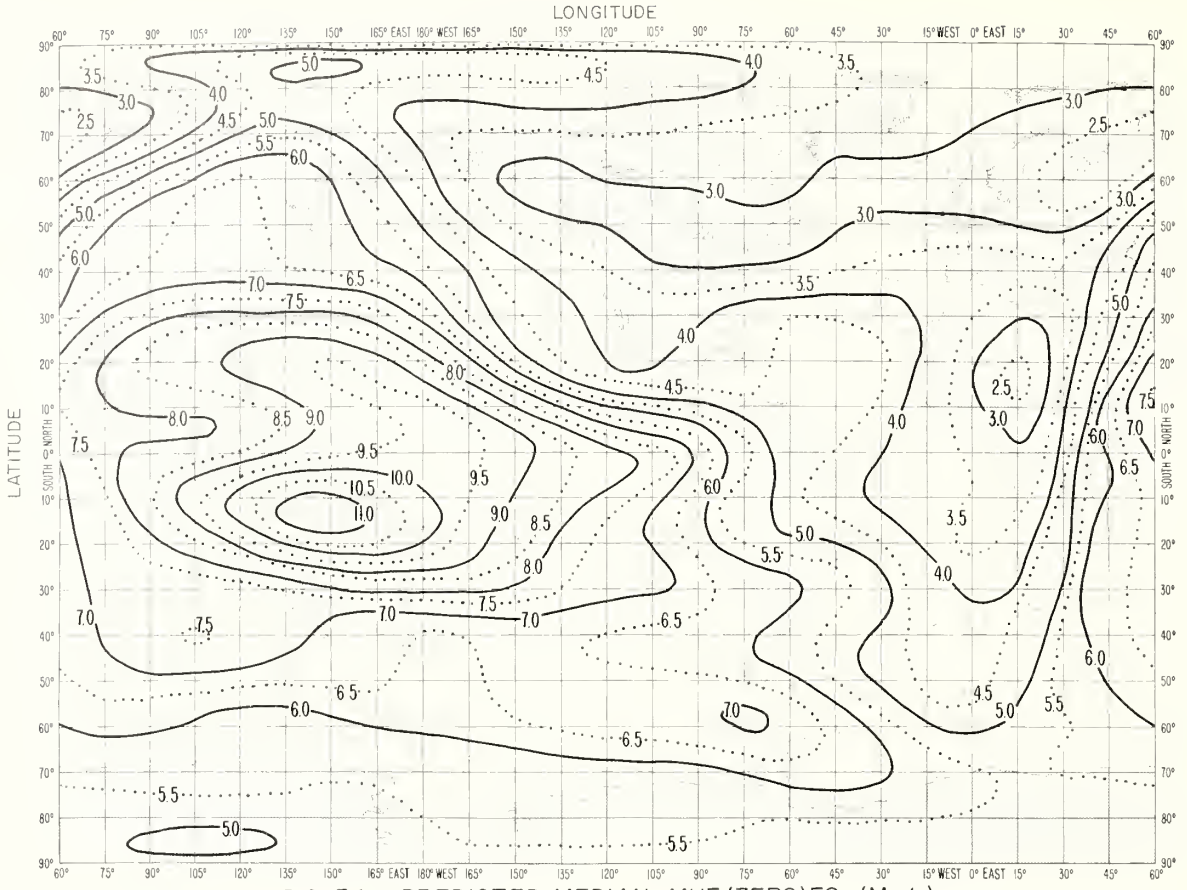

FIG. 3A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

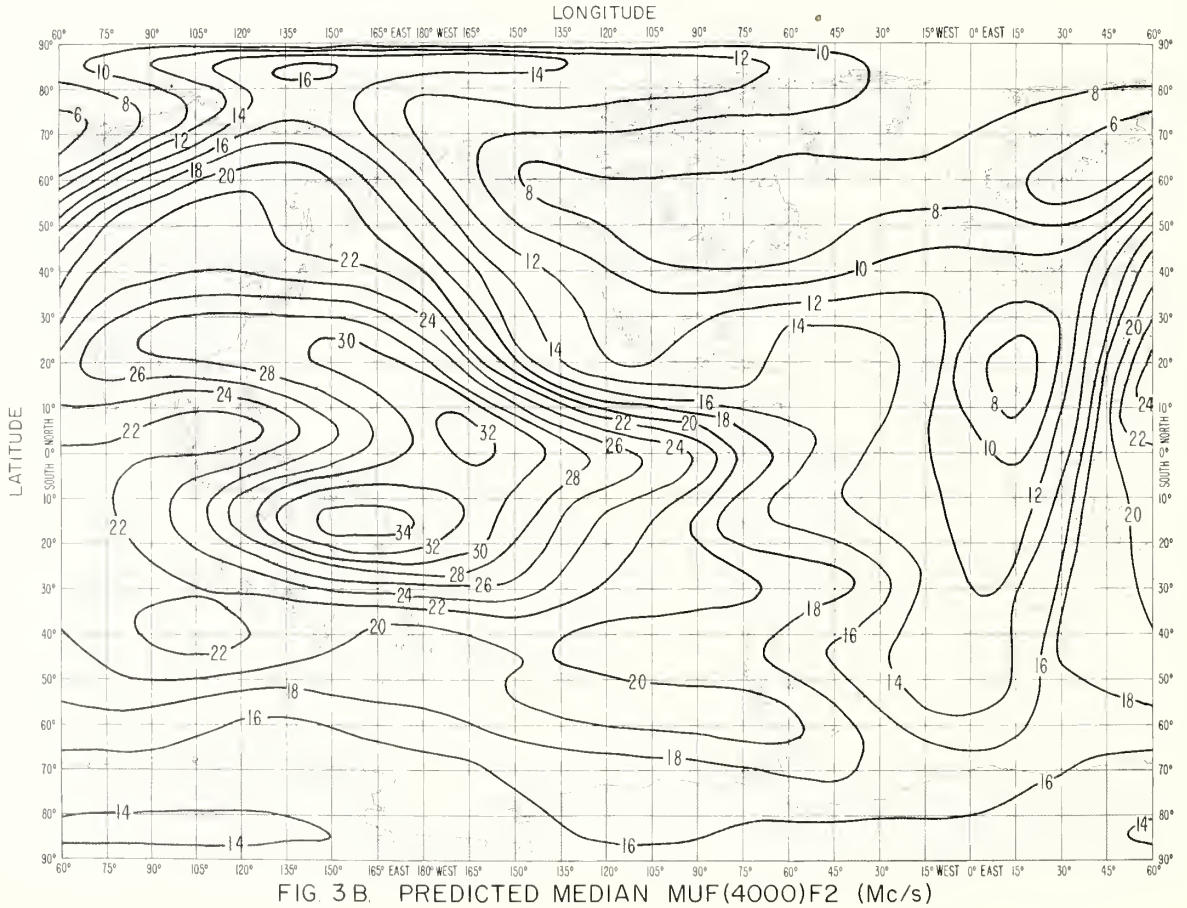

FIG. 3B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

DECEMBER 1963 UT=06

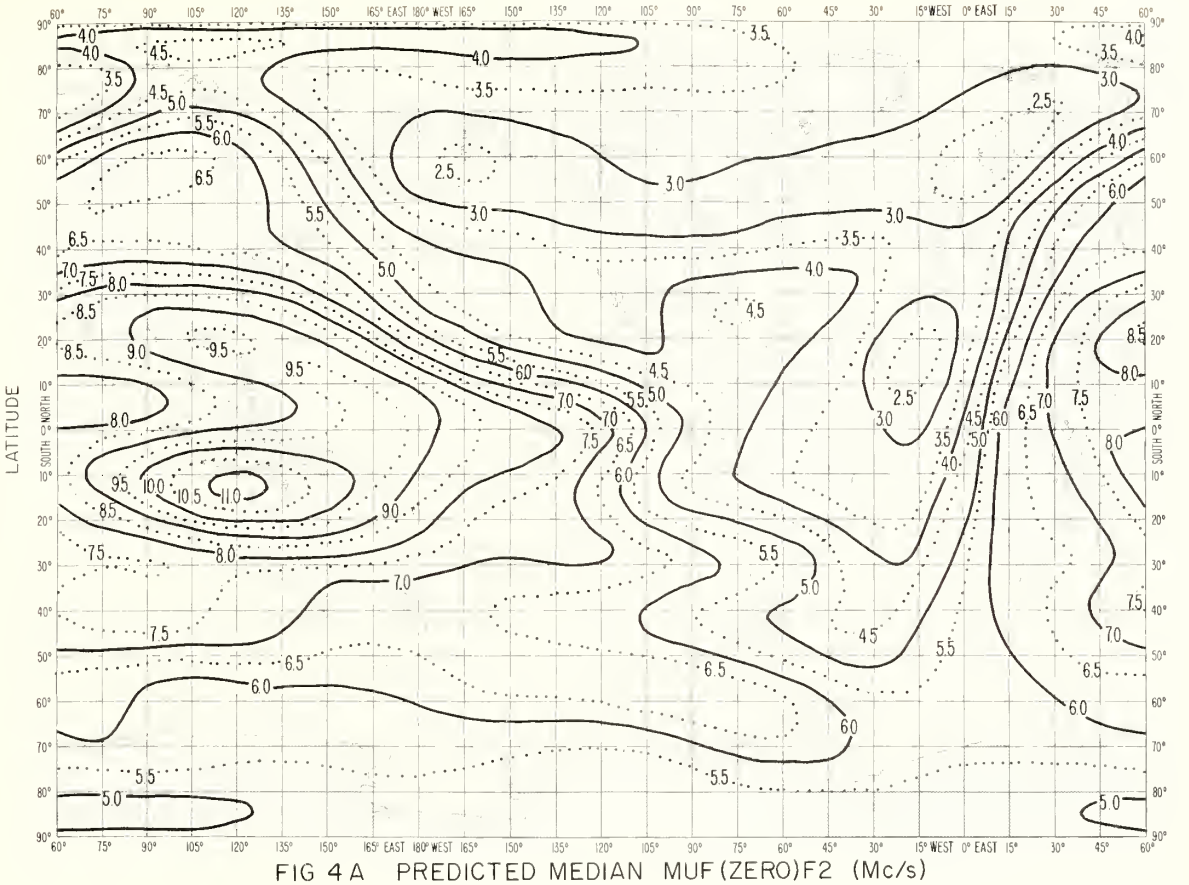

FIG 4A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

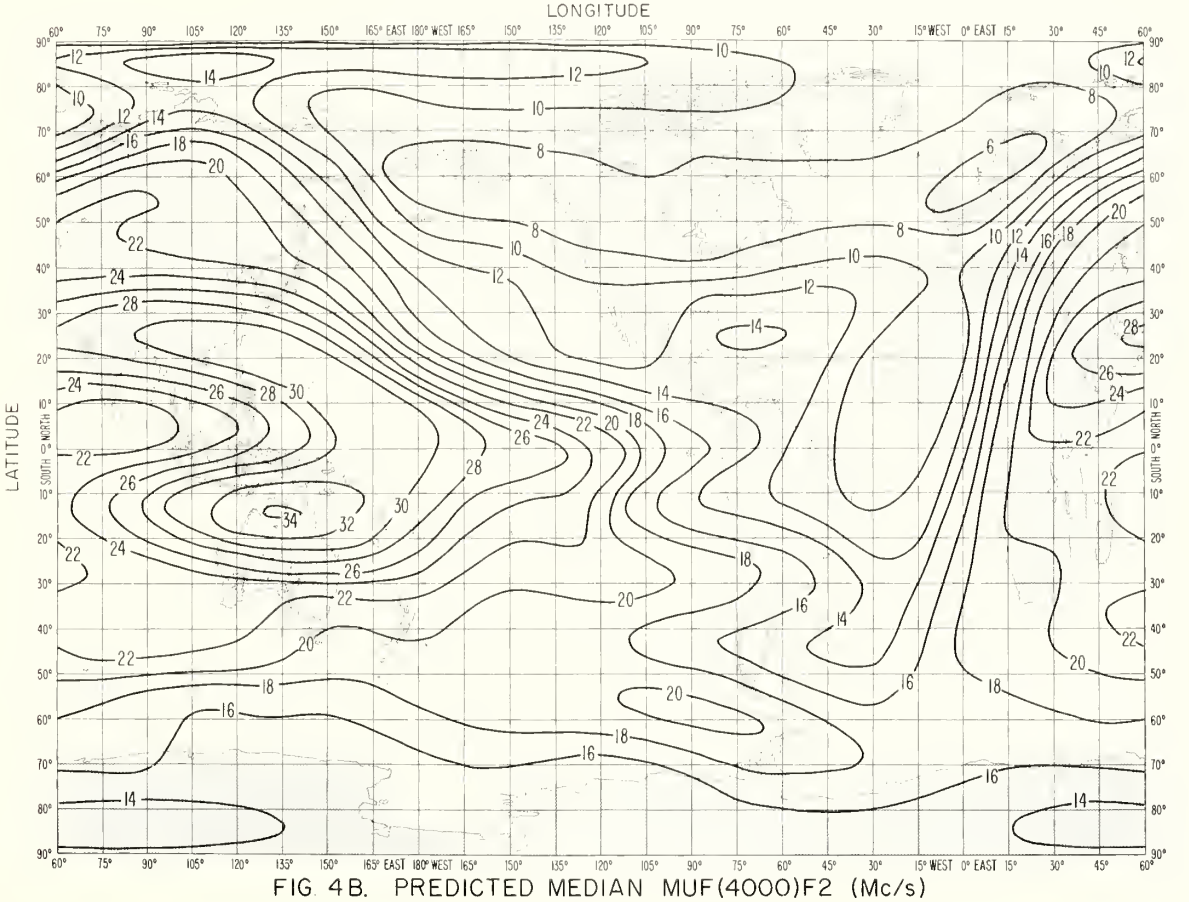

FIG 4B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

DECEMBER 1963 UT= 08

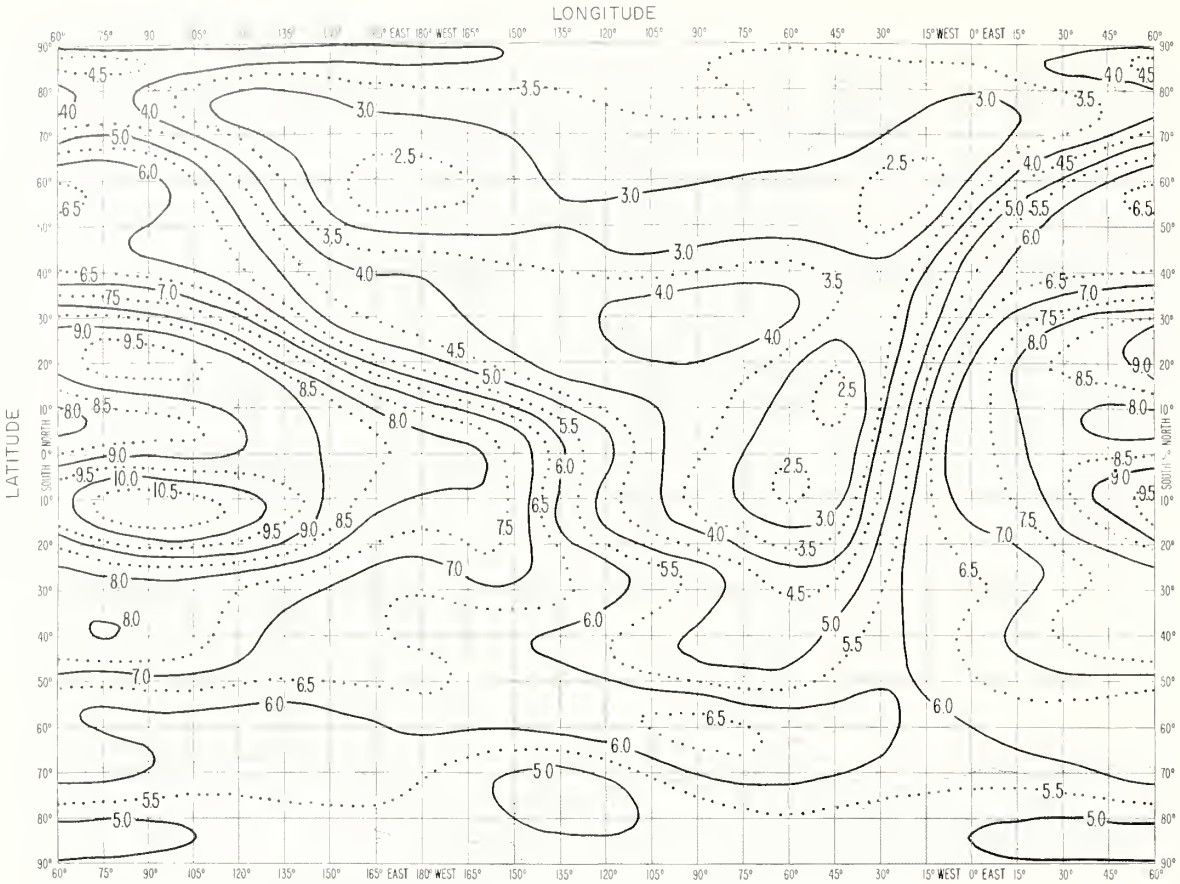

FIG 5A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

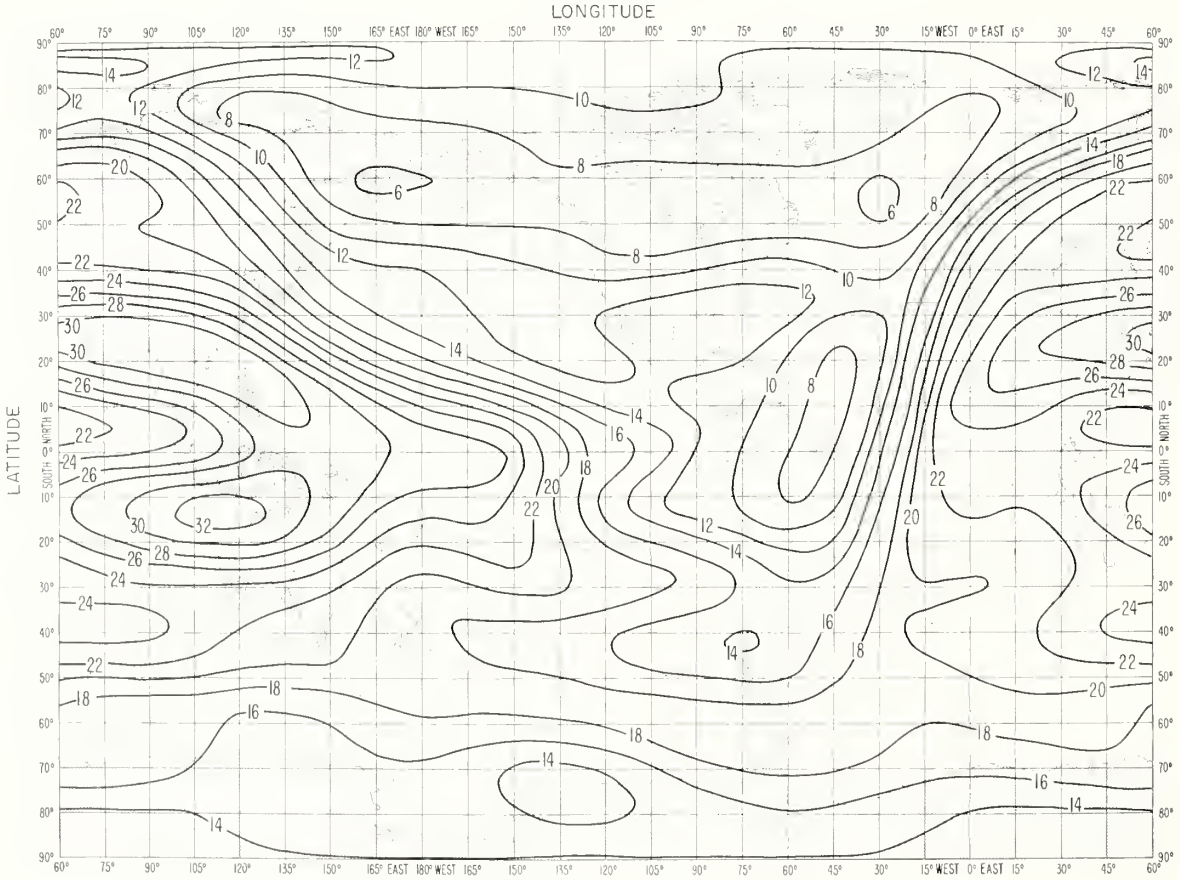

FIG 5B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

DECEMBER 1963 UT=10

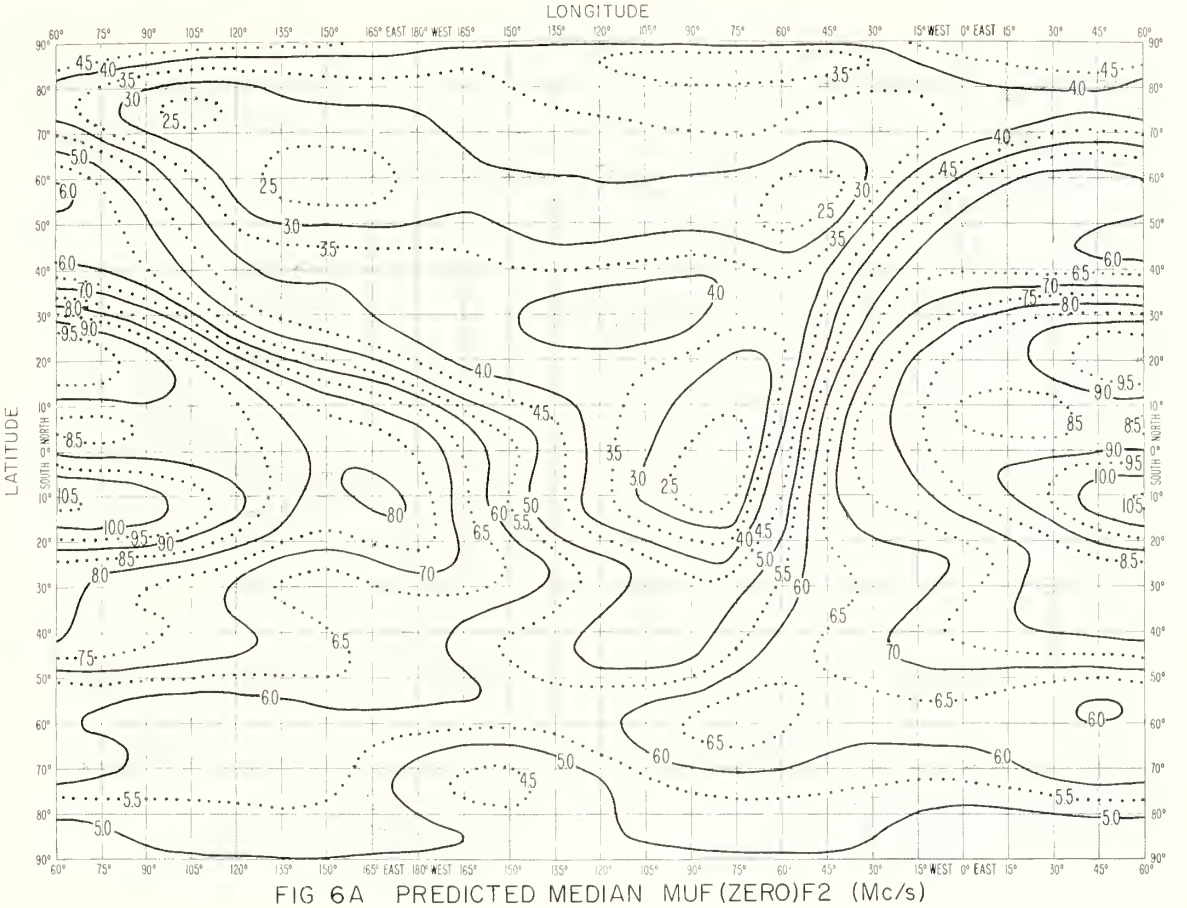

FIG 6A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

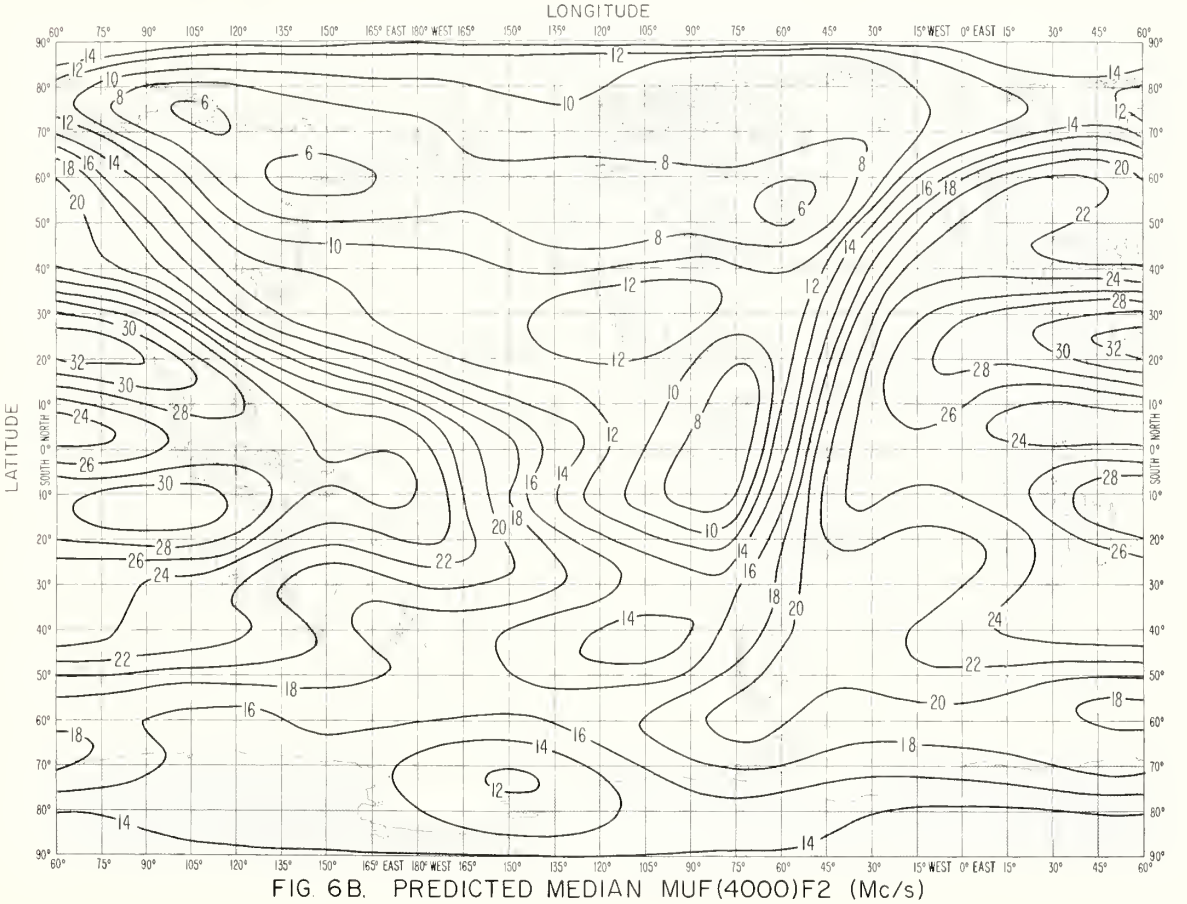

FIG 6B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

DECEMBER 1963 UT=12

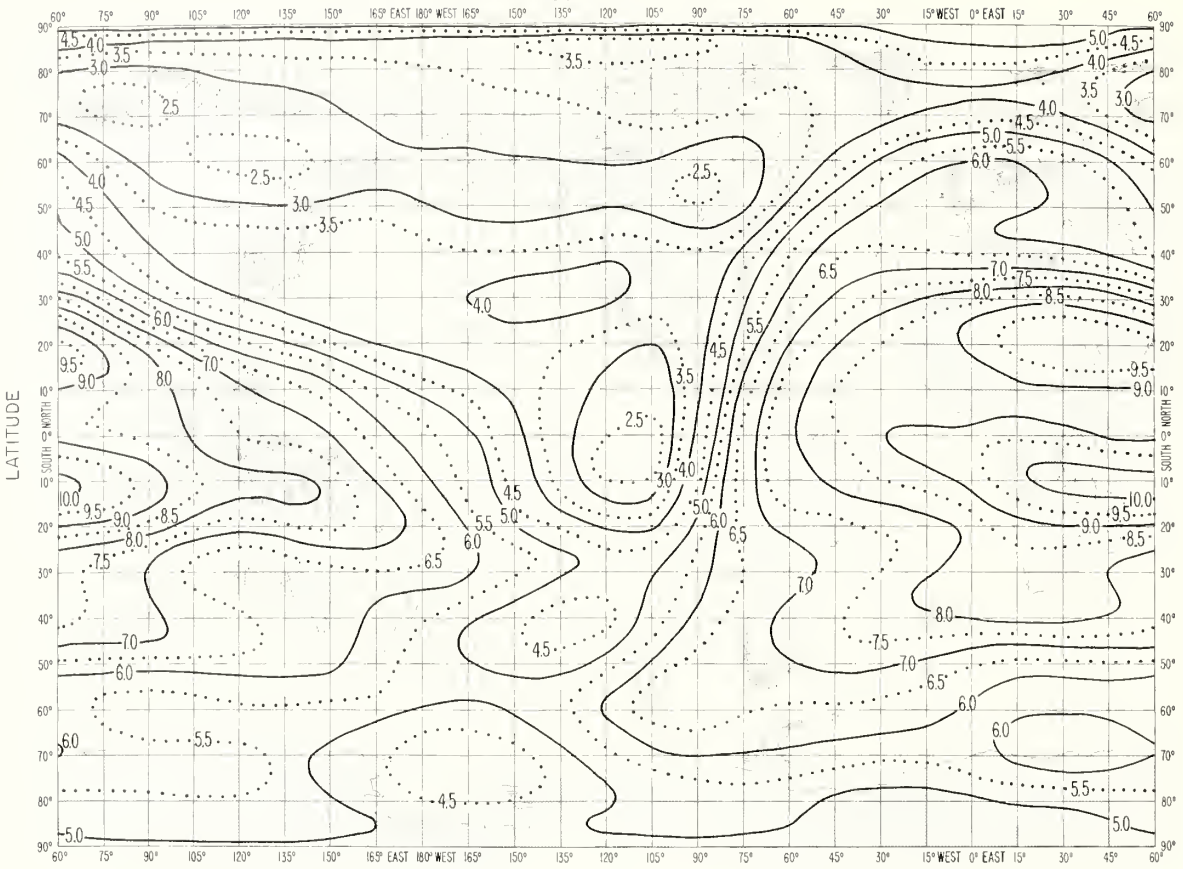

FIG 7A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

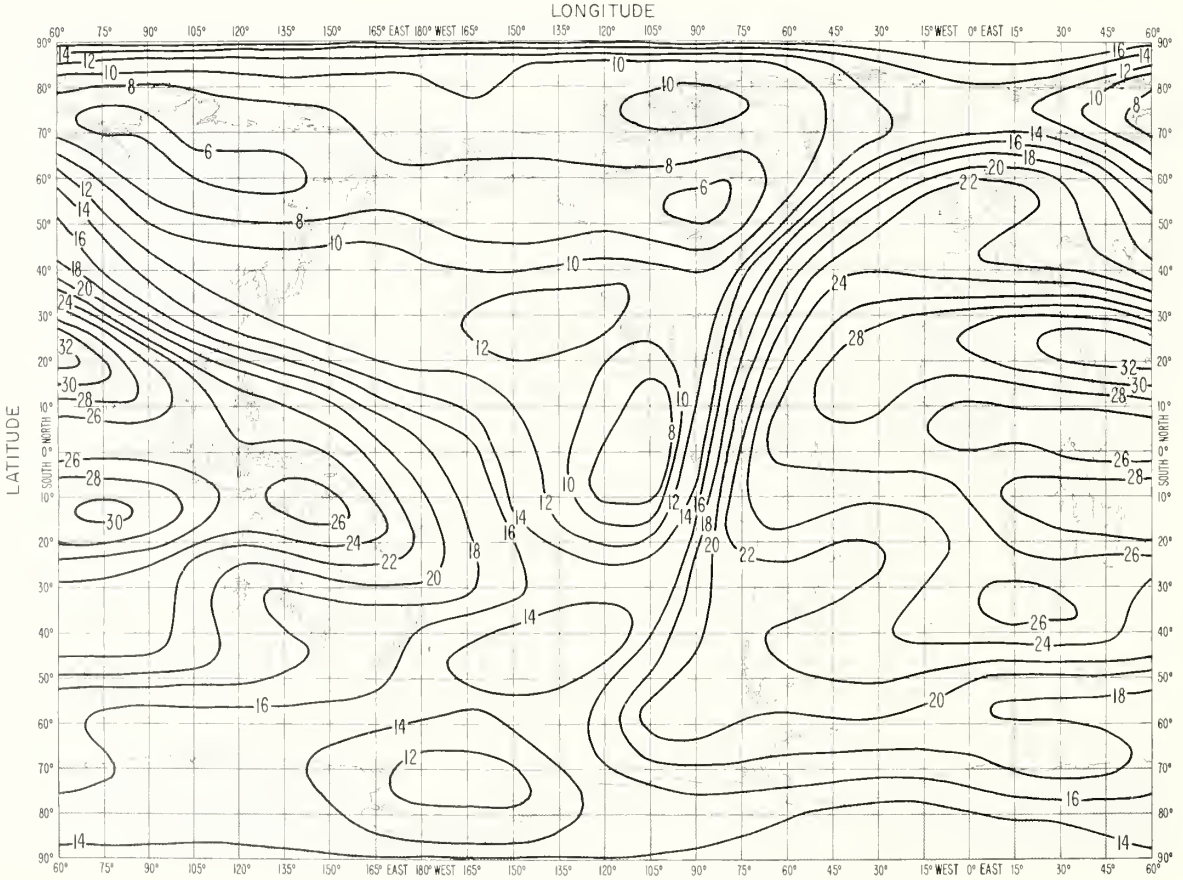

FIG 7B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

DECEMBER 1963 UT=14

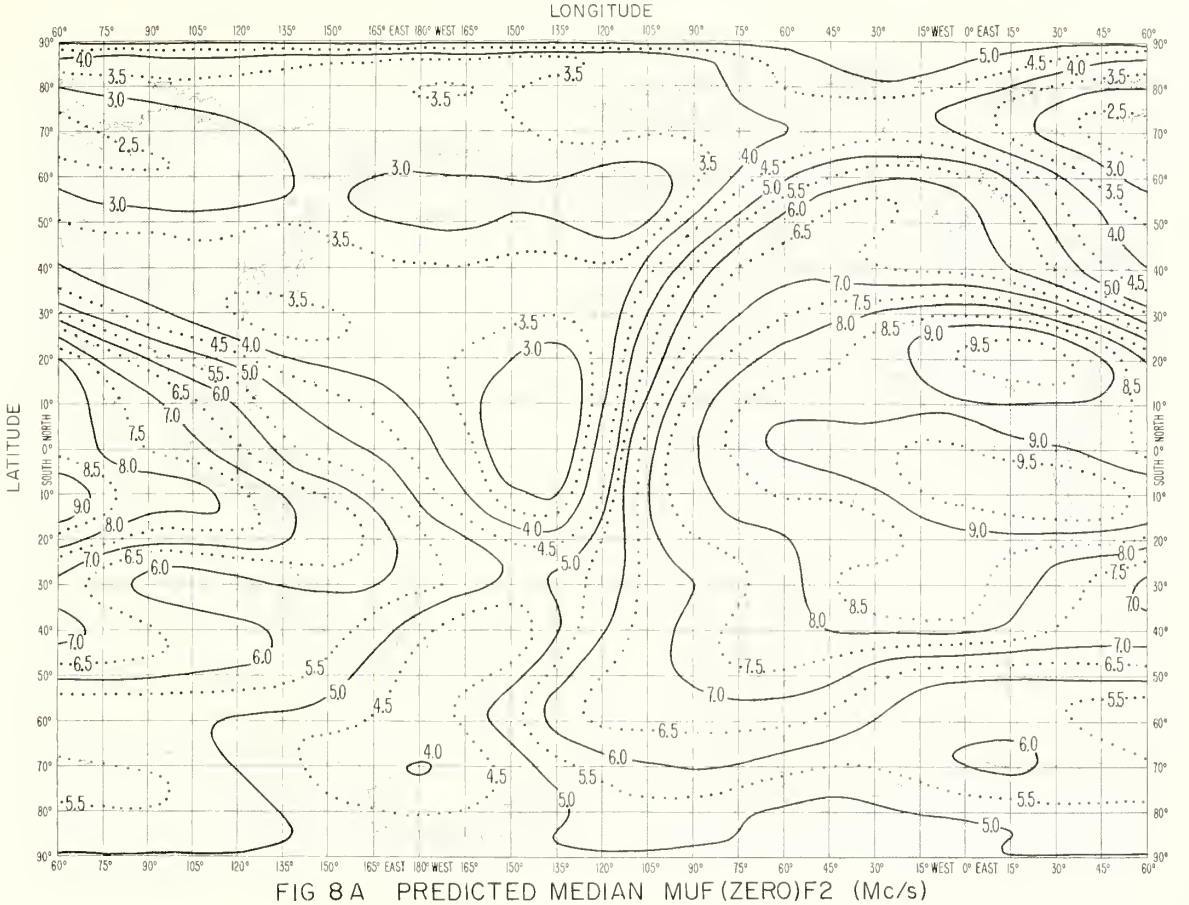

FIG 8A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

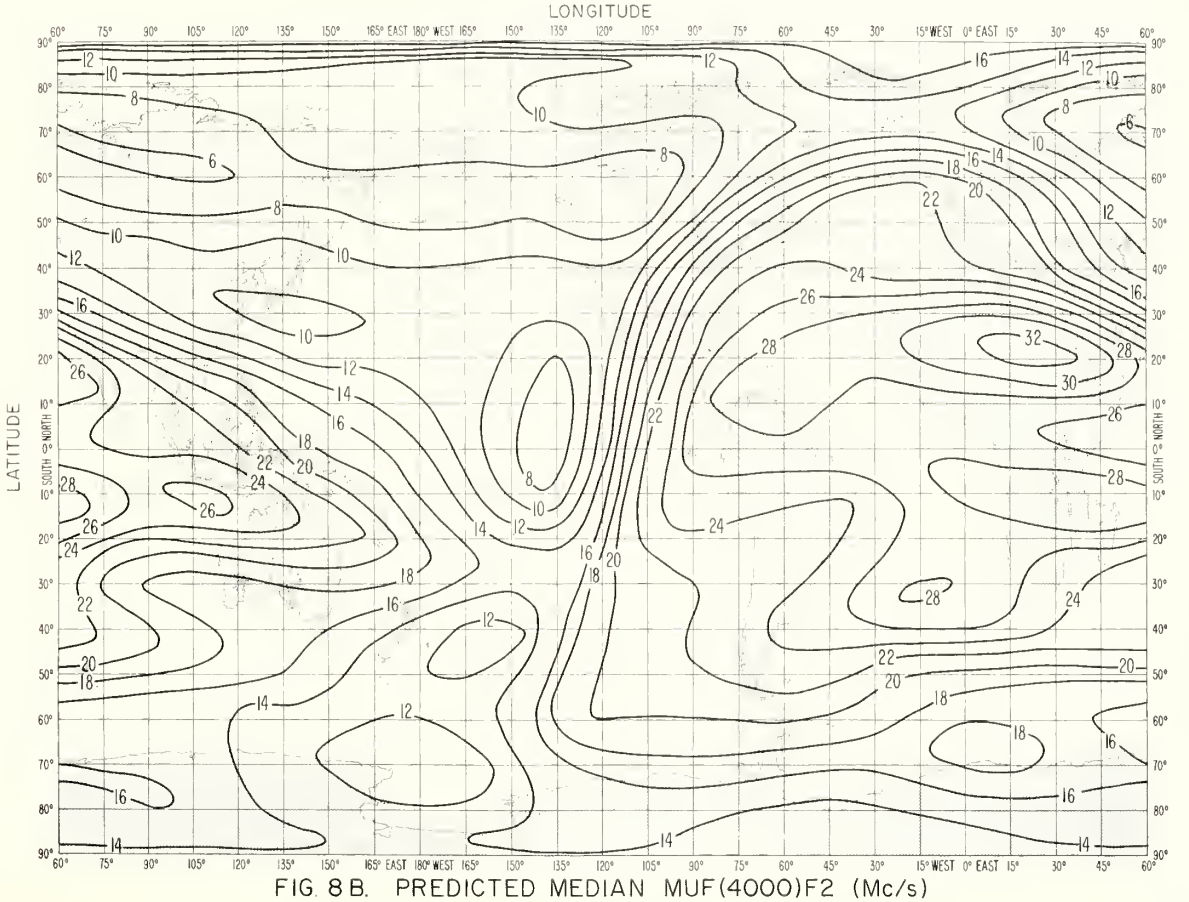

FIG. 8B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

DECEMBER 1963 UT=16

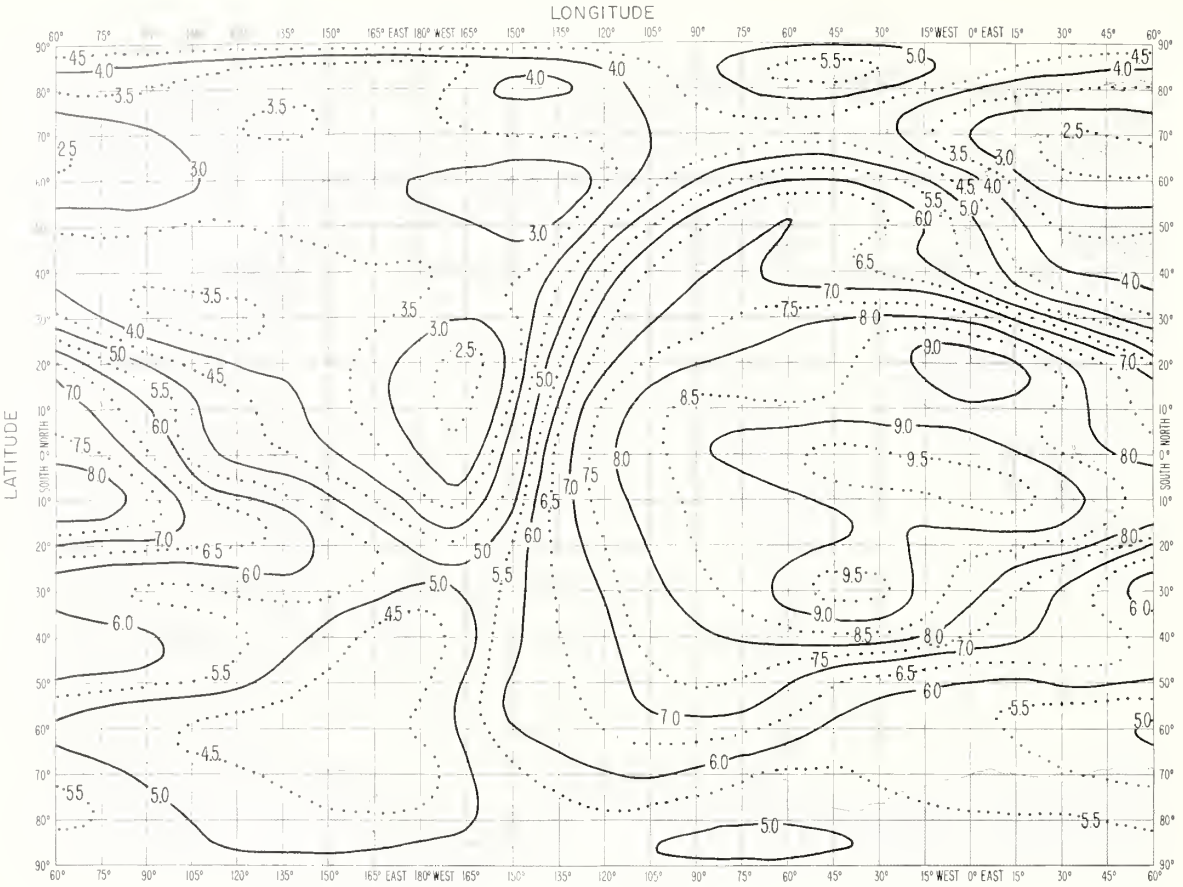

FIG 9A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

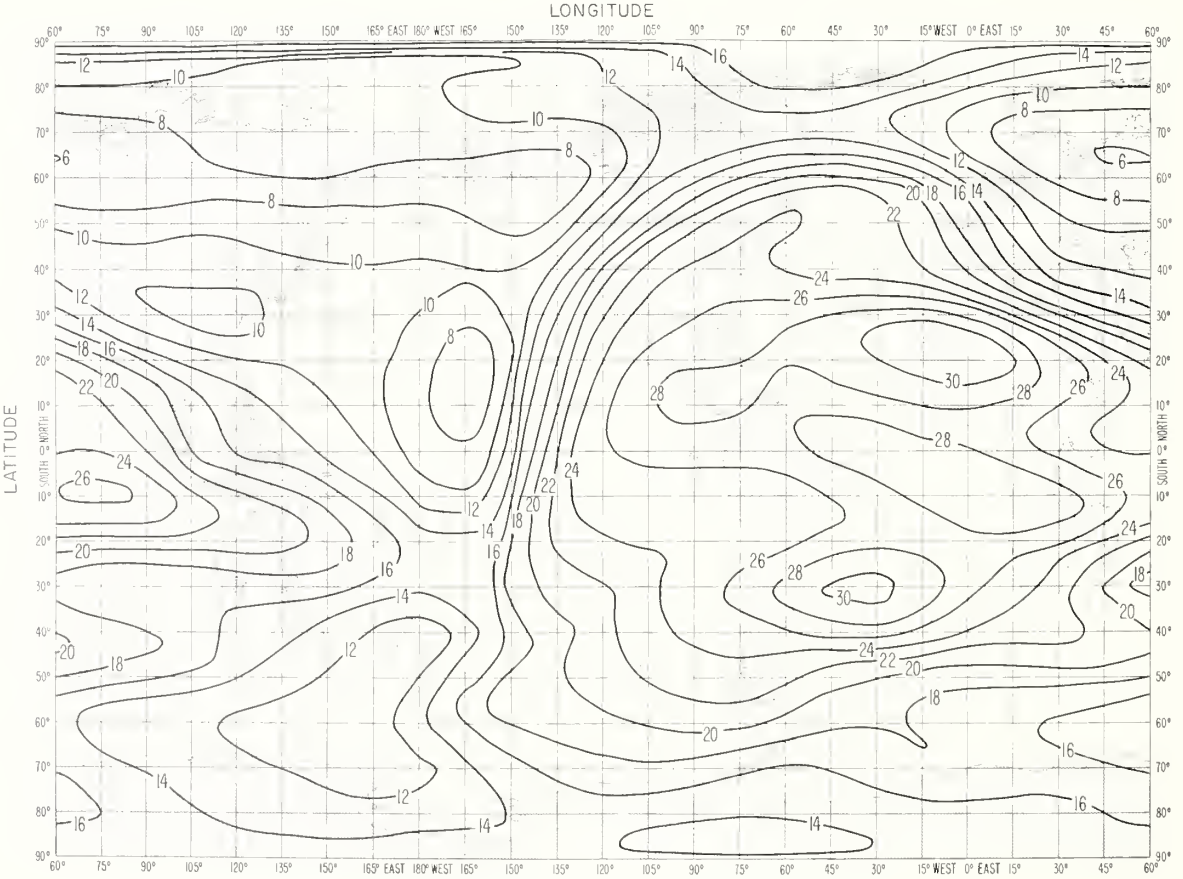

FIG 9B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

DECEMBER 1963 UT=18

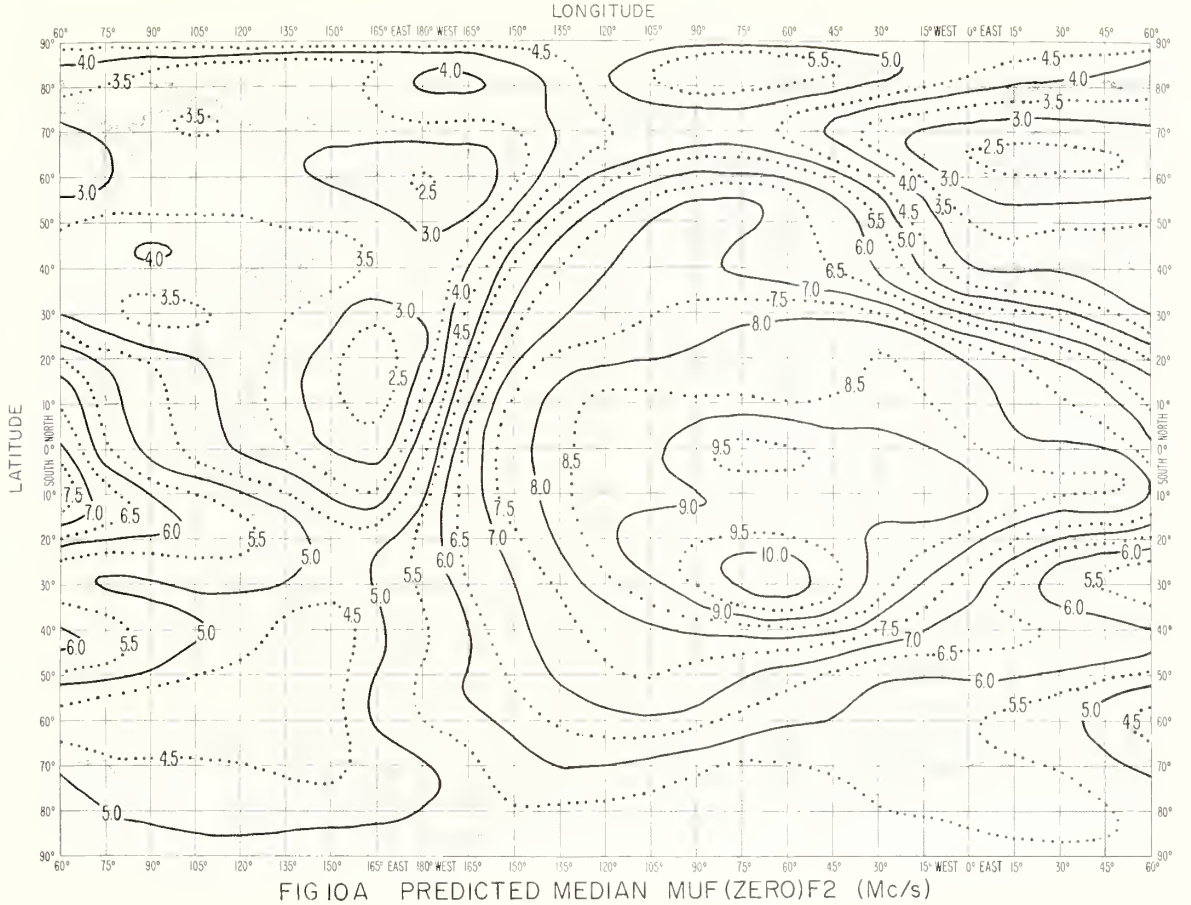

FIG 10A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

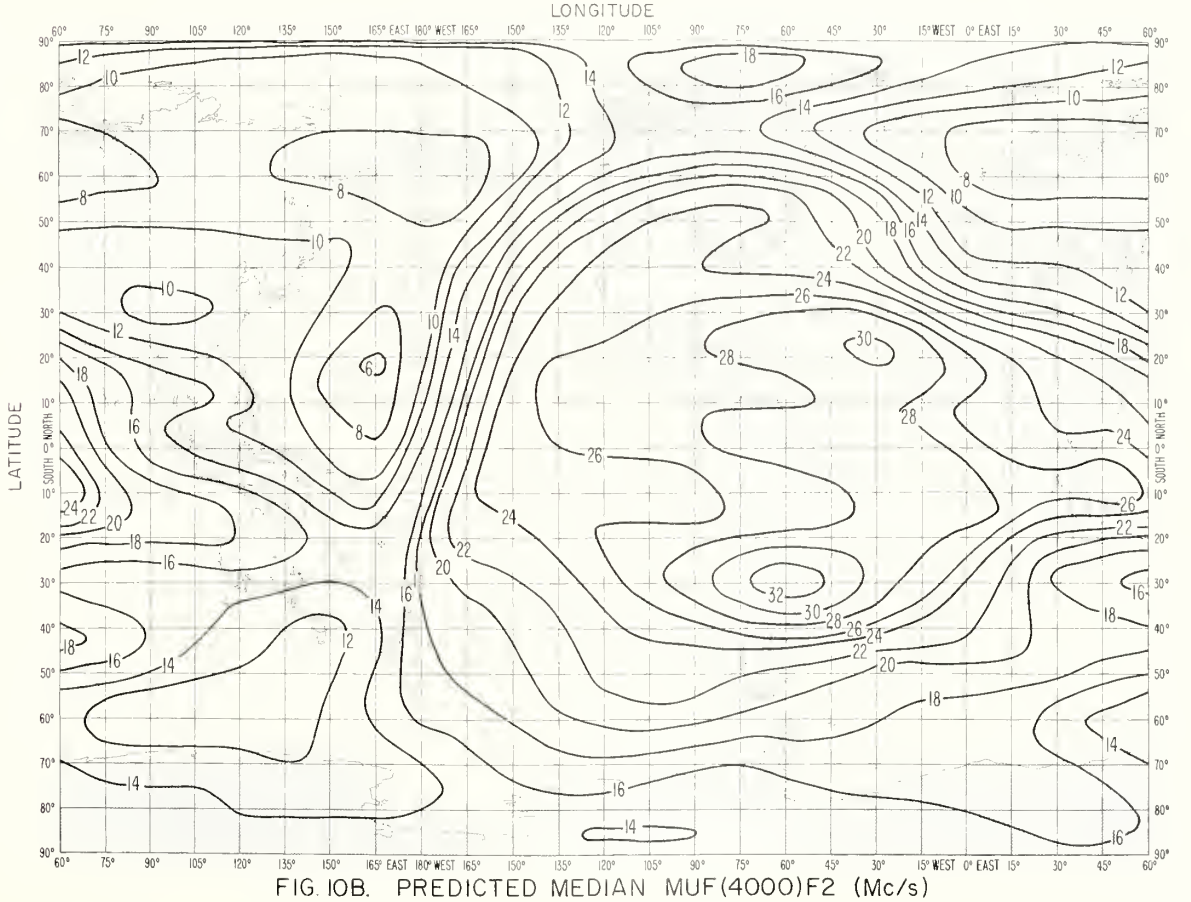

FIG. 10B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

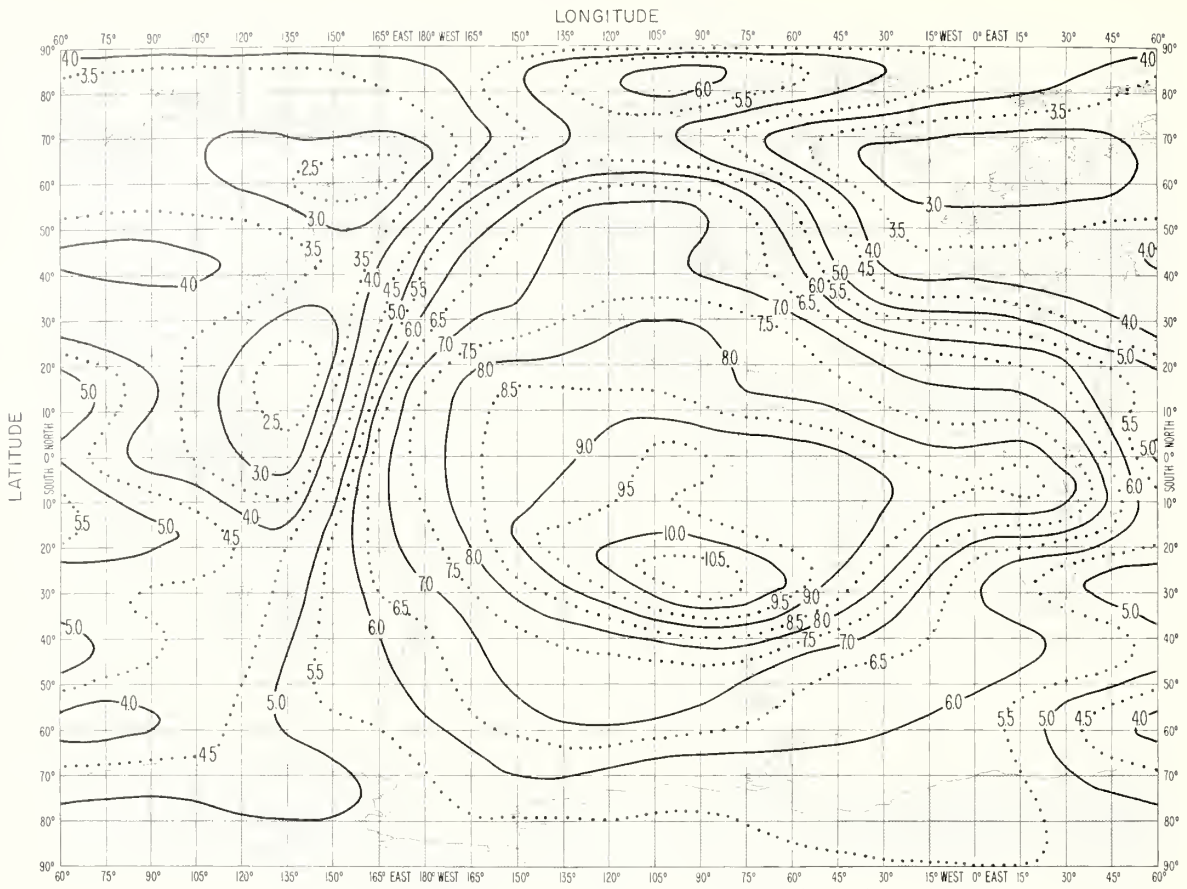

FIG. 11A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

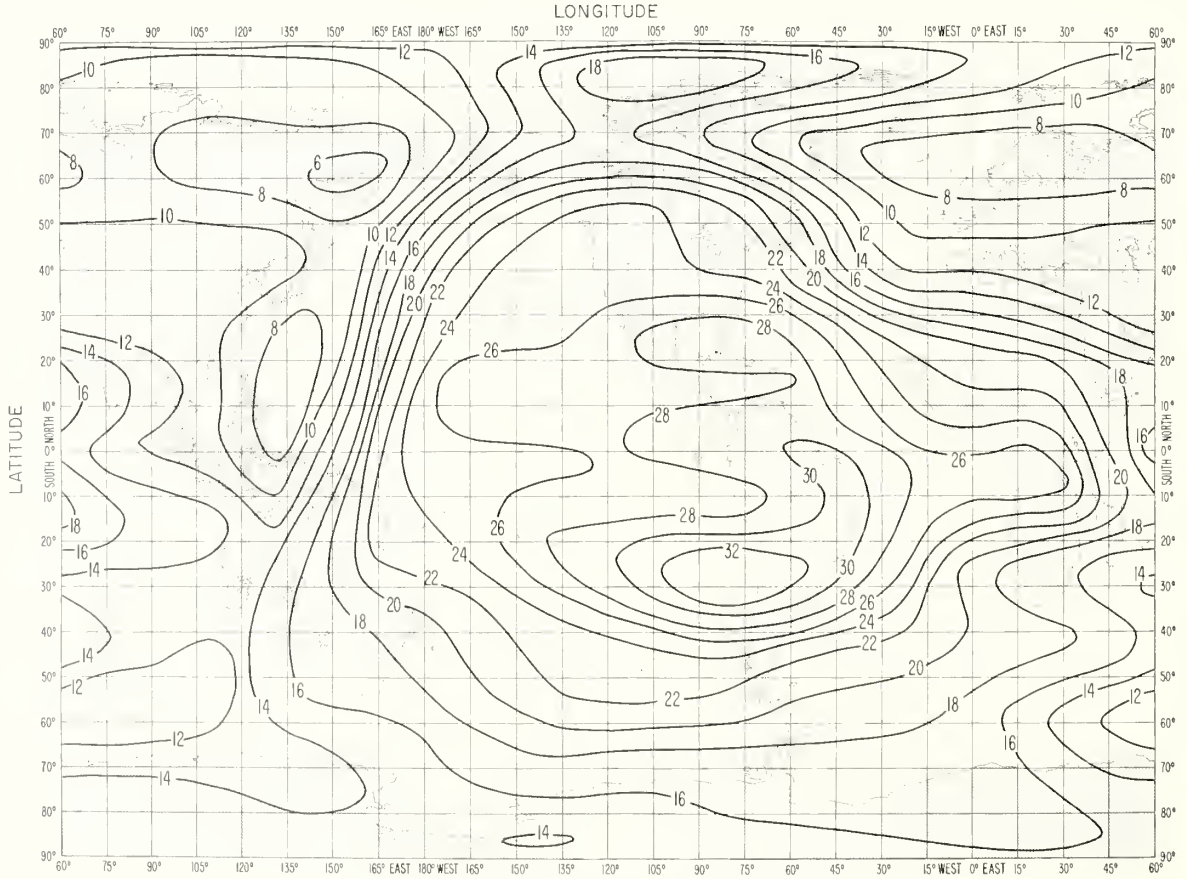

FIG. 11B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

DECEMBER 1963 UT=22

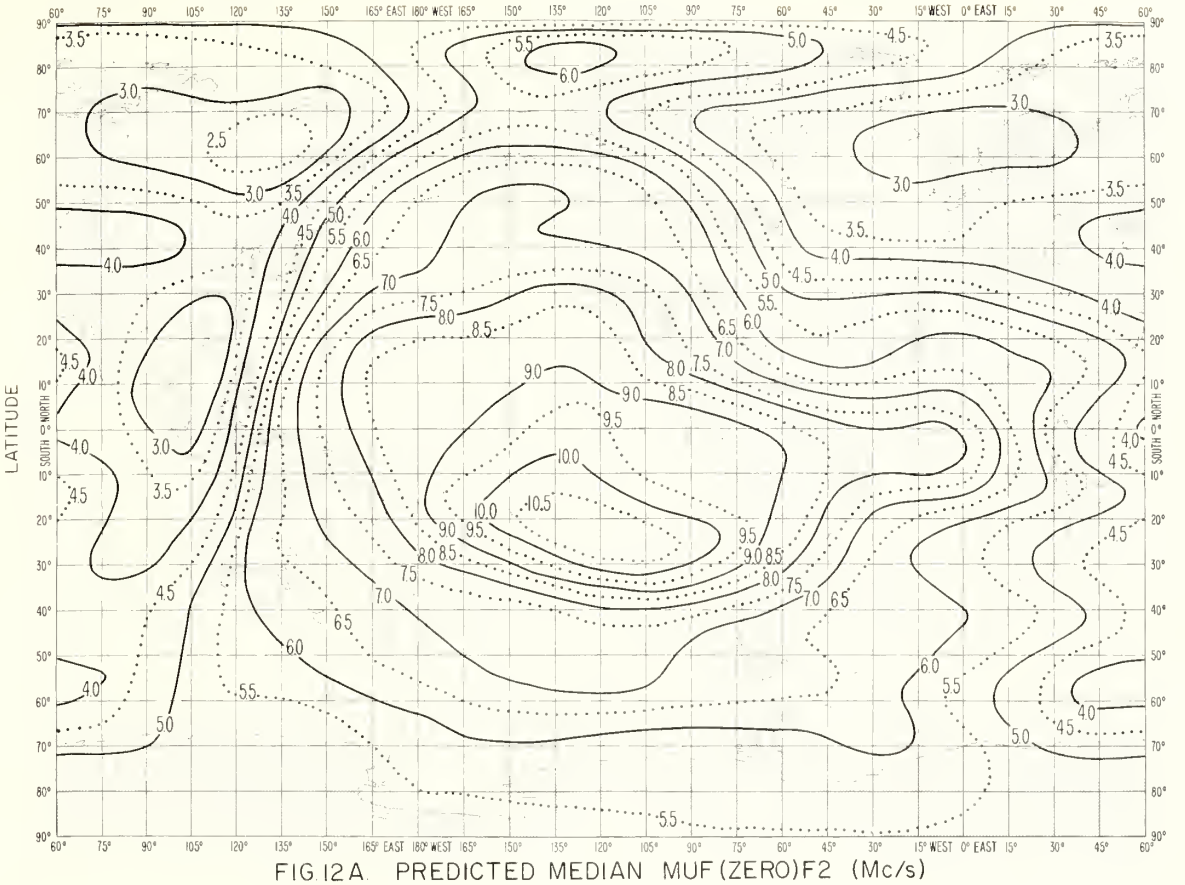

FIG.12A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

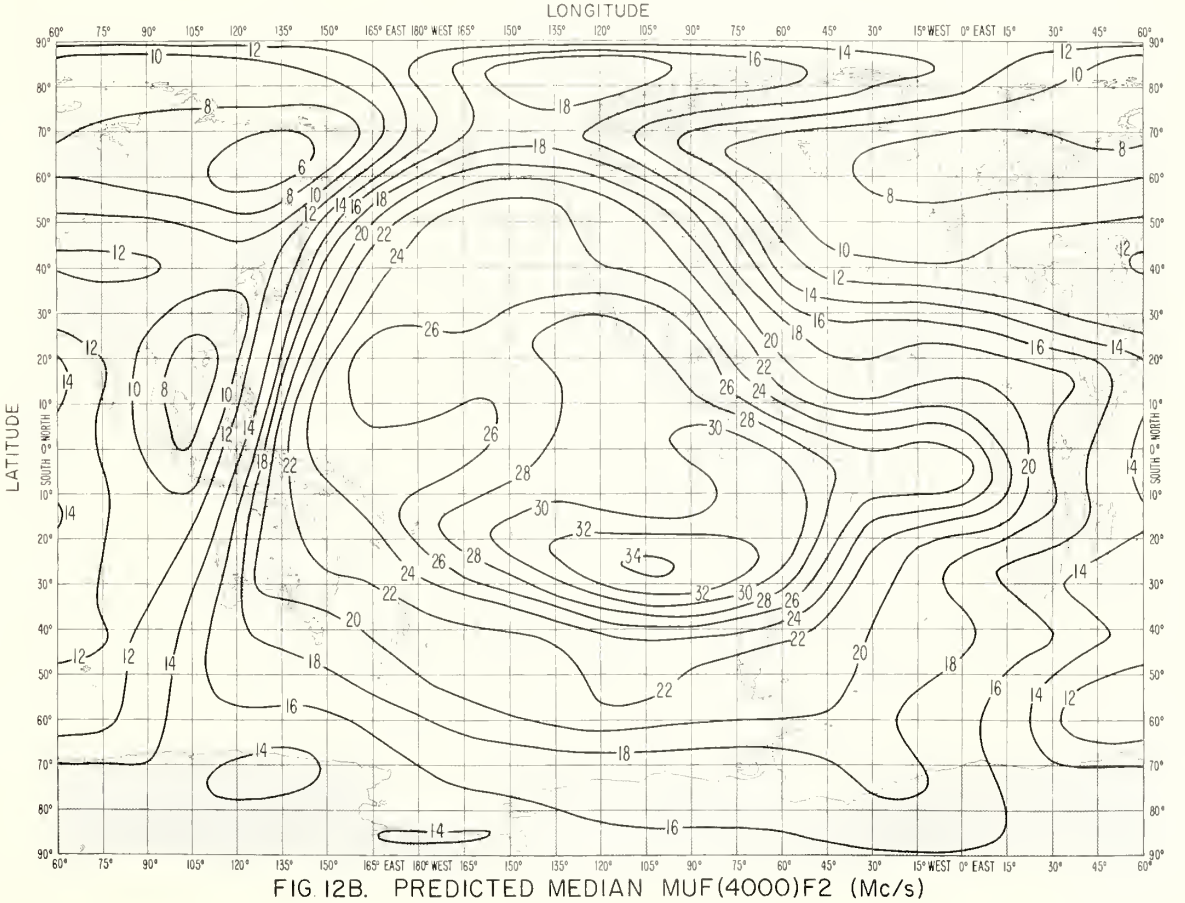

FIG.12B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

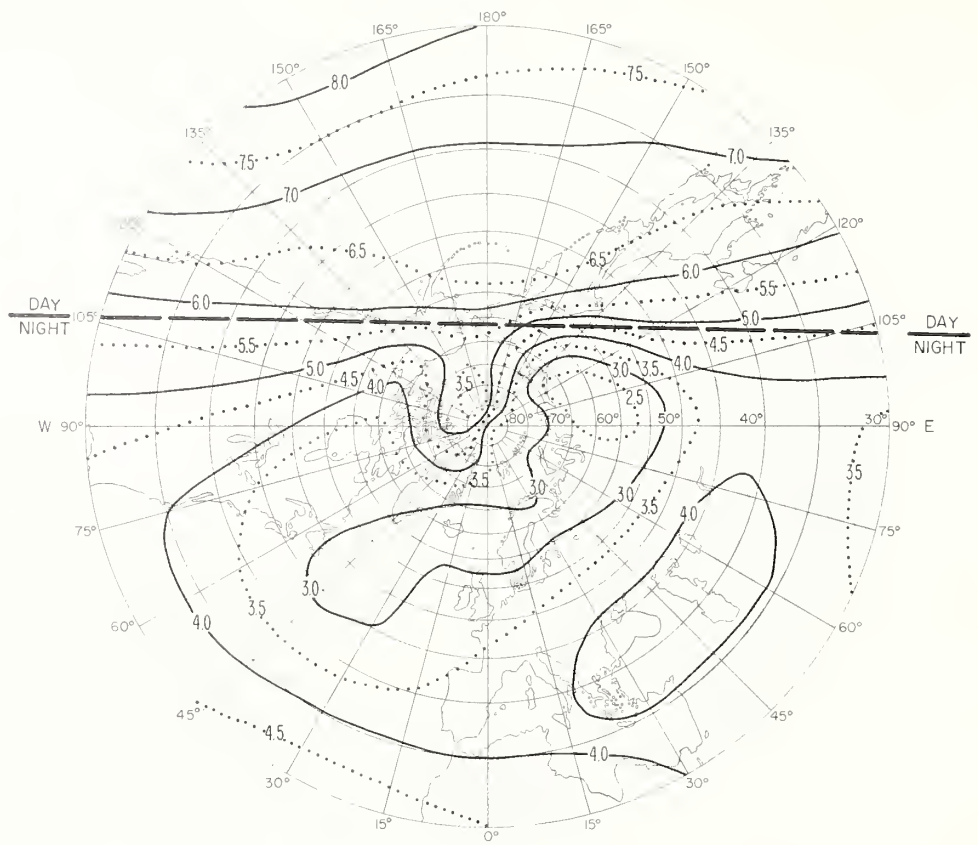

FIG. 13A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

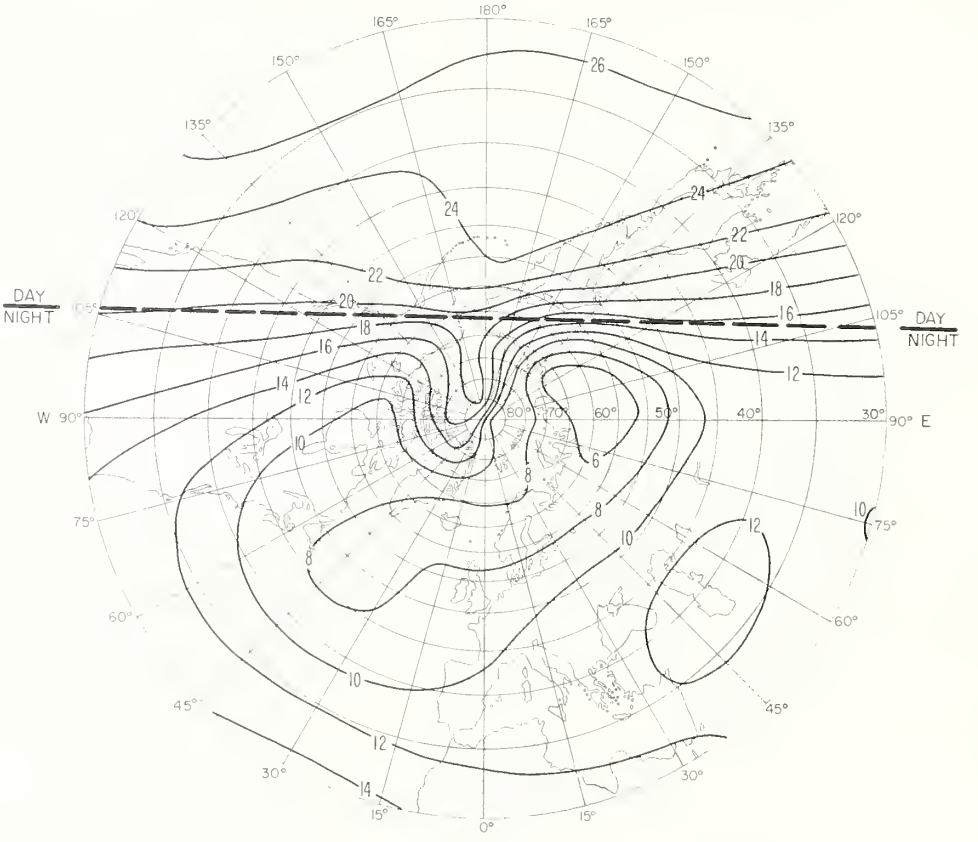

FIG. 13B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

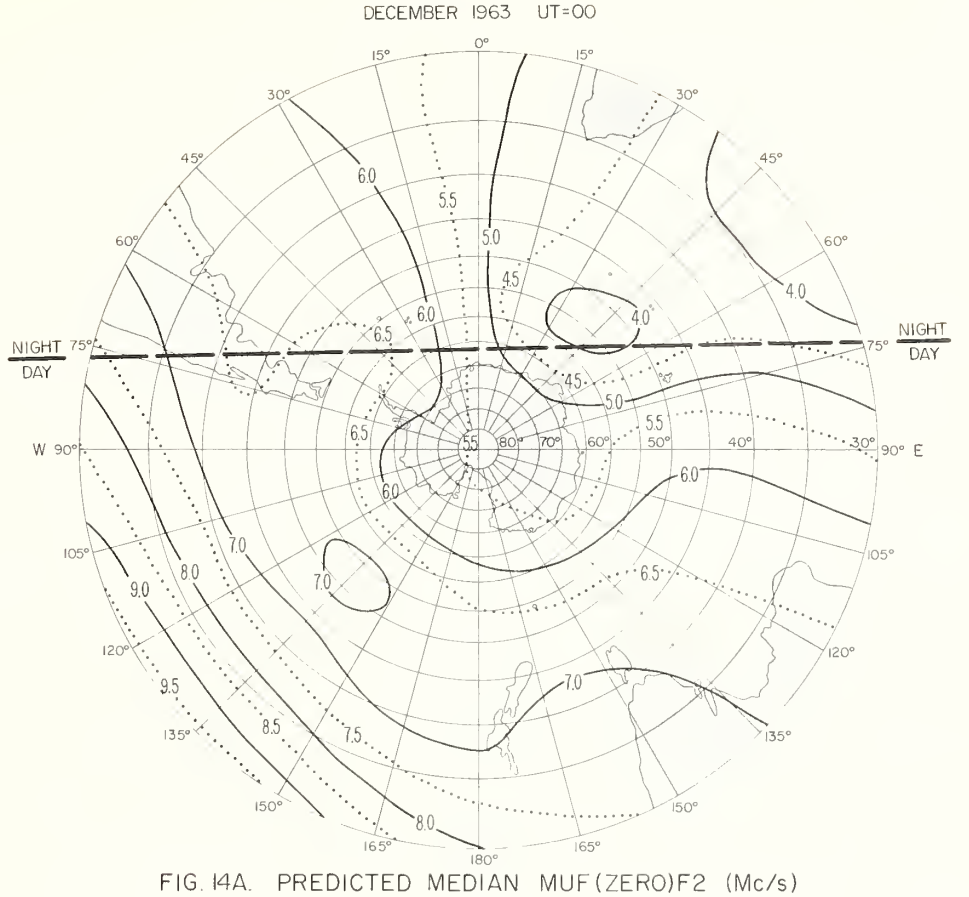

FIG. 14A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

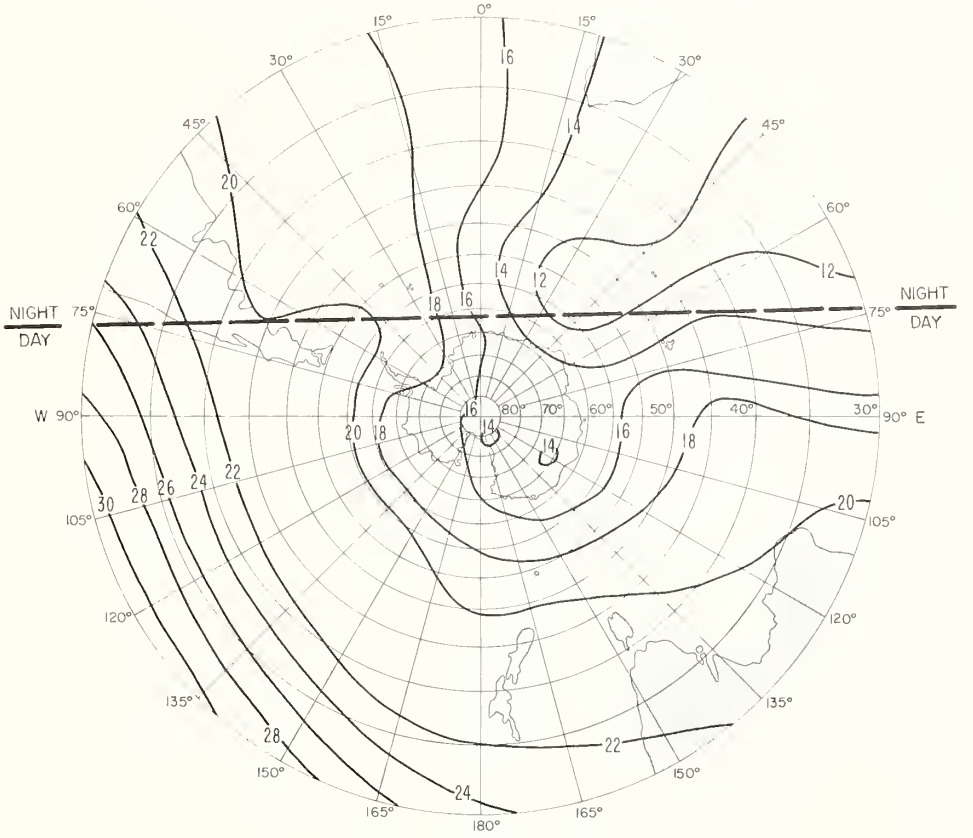

FIG. 14B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

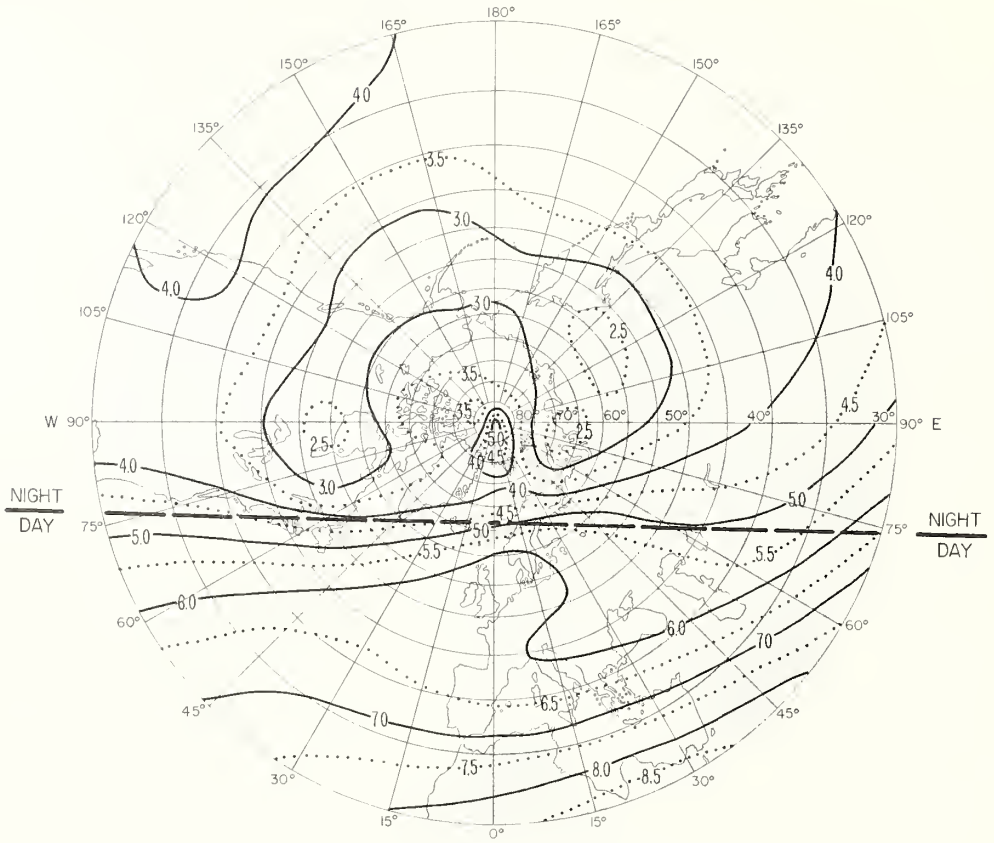

FIG. 15A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

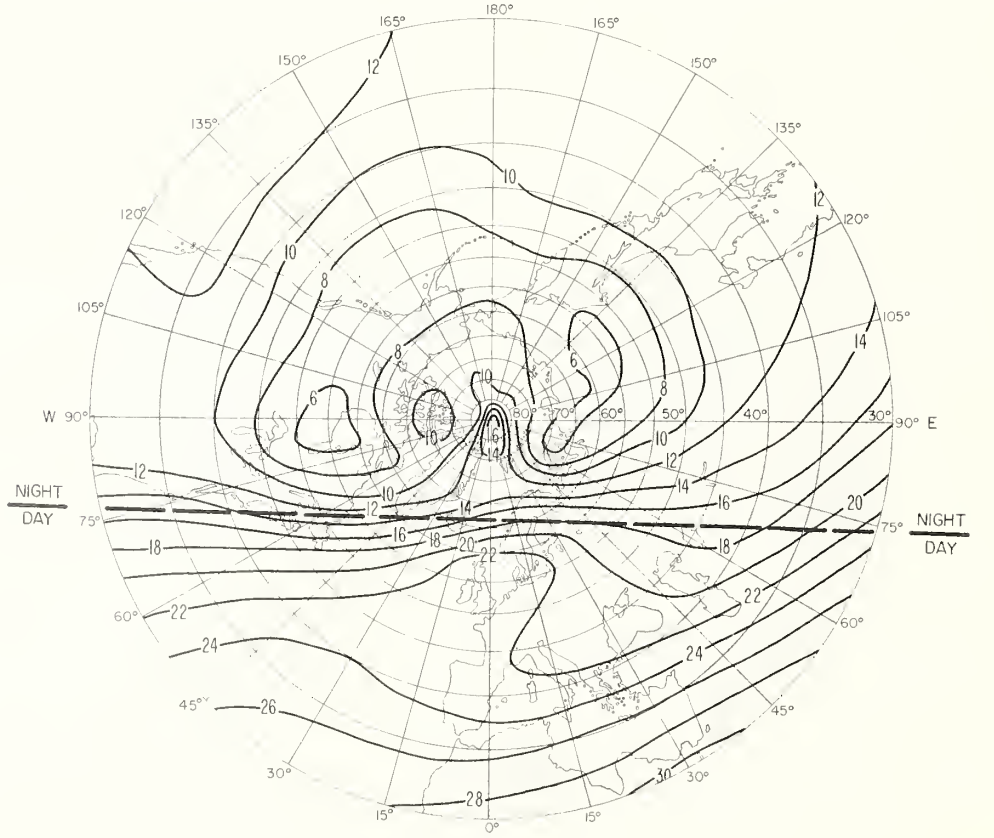

FIG. 15B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

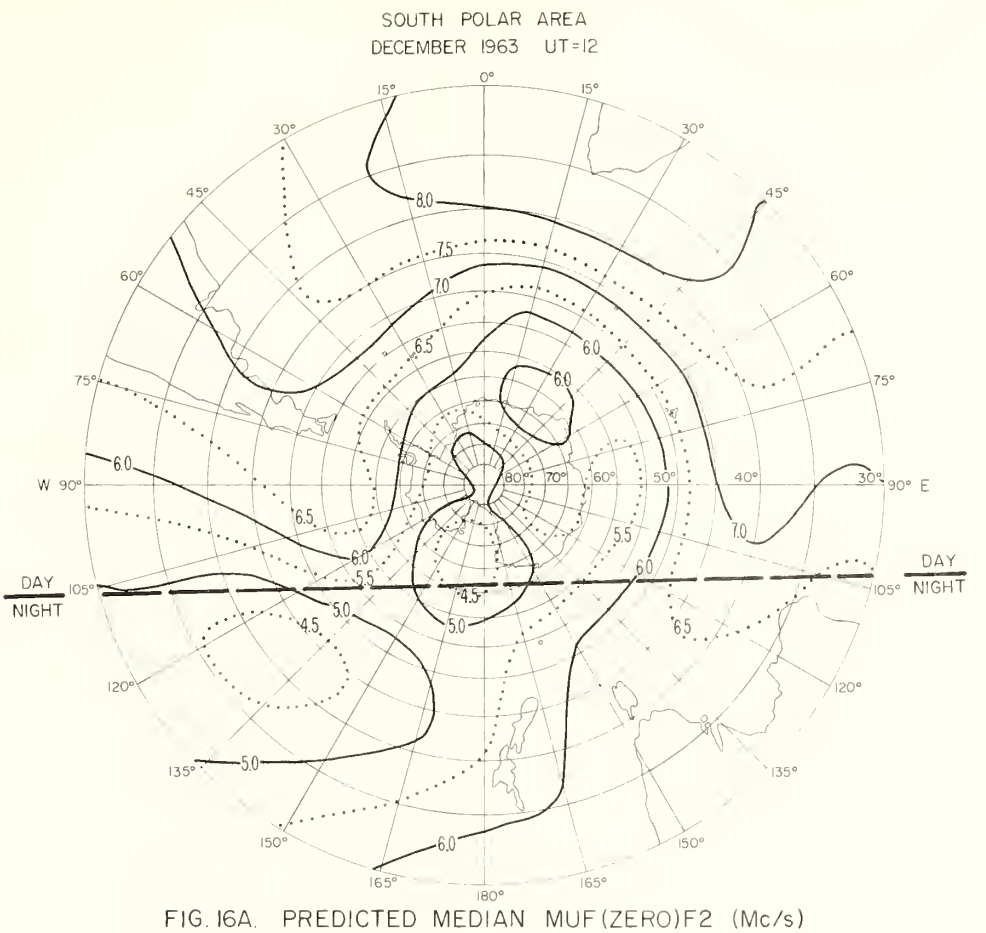

FIG. 16A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

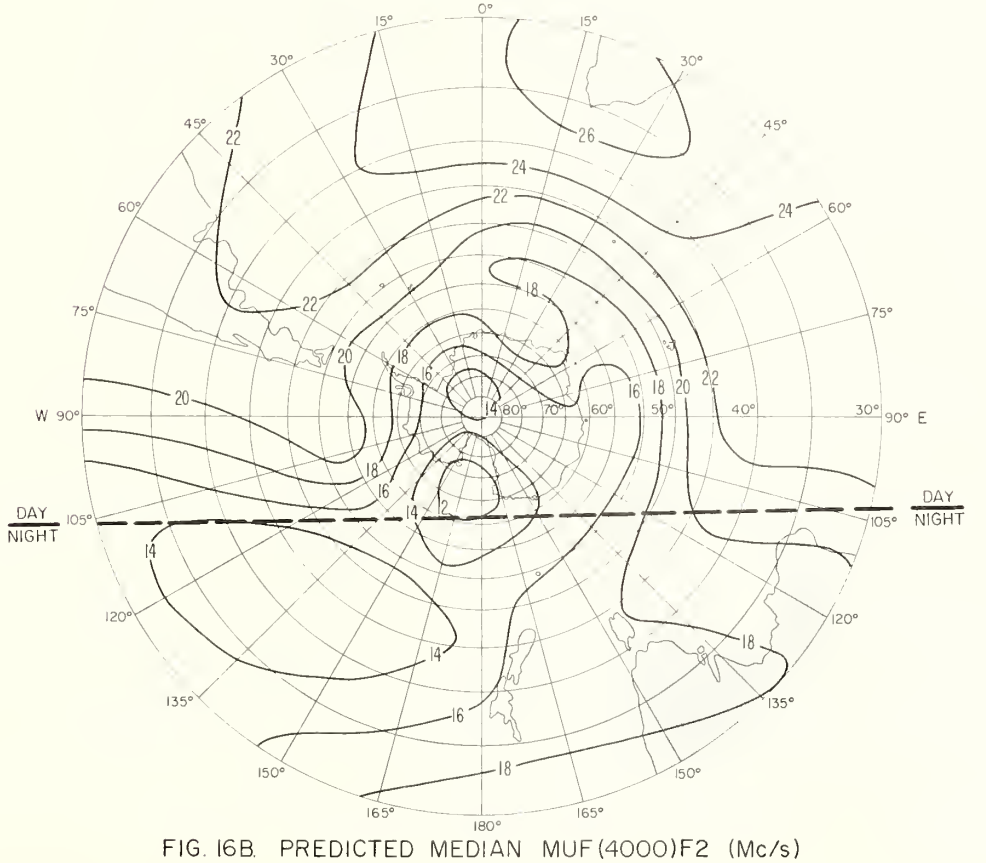

FIG. 16B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

ERRATUM

Table 1 for May 1963 (IP#2) through October 1963 (IP#7) should be amended as follows:

> The cutoff for the coefficients for the first order in longitude (II) should occur after k=36. The coefficients for the second order in longitude (III) should begin with k=37 and continue through k=52.

This error in Table 1 did not occur in the computations for the world-map contours. Figures 1 through 16 are correct as published.

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C., 20402

U.S. DEPARTMENT OF COMMERCE
Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title.

WASHINGTON, D. C.

Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage. Absolute Electrical Measurements.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Polymers. Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

Metallurgy. Engineering Metallurgy. Microscopy and Diffraction. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

Inorganic Solids. Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

Office of Weights and Measures.

BOULDER, COLO.

Cryogenic Engineering Laboratory. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Cryogenic Technical Services.

CENTRAL RADIO PROPAGATION LABORATORY

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

Radio Propagation Engineering. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

Radio Systems. Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Frequency Utilization. Modulation Research. Antenna Research. Radiodetermination.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. High Latitude Ionosphere Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

RADIO STANDARDS LABORATORY

Radio Physics. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Millimeter-Wave Research.

Circuit Standards. High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D. C., 20402

OFFICIAL BUSINESS

PENALTY FOR PRIVATE USE TO AVOID
PAYMENT OF POSTAGE, $300
(GPO)

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
WASHINGTON, D. C., 20301, *1 September 1963*

TB 11-499-9/TO 31-3-28, CRPL Ionospheric Predictions for December 1963, published for the use of all concerned.

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff.

OFFICIAL:
J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

CURTIS E. LeMAY,
Chief of Staff, United States Air Force.

OFFICIAL:
R. J. PUGH,
Colonel, United States Air Force,
Director of Administrative Services.

DISTRIBUTION:
Active Army:
USASA (4); USA Elct Comd (1); CSigO (1); USA MI Comd (1); USA Test & Eval Comd (1); USACD Agcy (1); USA Msl Spt Comd (1); USCONARC (3); ARADCOM (2); OS Maj Comd (5); OS Base Comd (2); Log Comd (2); MDW (1); Armies (5); Corps (2); Div (2); USA Elct RD Agcy (4); Svc Colleges (4); Br Svc Sch (4) except USASCS (20); USAADCEN (4); ARADCOM Rgn (2); WSMR (2); USA Elct RD Actv (4); JBUSMC (12); USA Corps (1); USA Mob Spt Cen (1); USAEPG (2); USAMC (1); Units org under fol TOE: 11-18 (1); 11-95 (1); 11-500 AC (1).

NG: None.
USAR: None.
For explanation of abbreviations used, see AR 320-50.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1963—O-